United States Circuit Court

NORTHERN DISTRICT OF NEW YORK

In Equity, No. 7025

CAMERON SEPTIC TANK COMPANY,
Complainants,

Cal. 0

vs.

VILLAGE OF SARATOGA SPRINGS AND THE SEWER, WATER AND STREET COMMISSION OF SARATOGA SPRINGS,
Defendants.

Pleadings and Proofs

JOHN J. HEALEY, JR.,
Saratoga Springs, N. Y.,
Solicitor for Defendants.

EPHRAIM BANNING,
Chicago, Ill.,

CHARLES L. STURTEVANT,
Washington, D. C.,
4
Of Counsel.

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" OWING TO AN ERROR ON THE PART OF THE PRINTER, THE FIRST 59 PAGES AND 294 FOLIOS OF THIS RECORD CONTAIN THE PRINTED COPY OF THE COMPLAINANT'S PRIMA FACIE CASE. TO AVOID, THEREFORE, THE TROUBLE AND EXPENSE OF ENTIRELY REPAGING AND RENUMBERING THE FOLIOS, THE CASE IS LEFT IN ITS PRESENT FORM, THE COURT'S ATTENTION BEING RESPECTFULLY CALLED TO THE ERROR."

United States Circuit Court

Northern District of New York

CAMERON SEPTIC TANK COMPANY,
Complainant, 1
against
VILLAGE OF SARATOGA SPRINGS, AND THE SEWER, WATER AND STREET COMMISSION OF SARATOGA SPRINGS,
Defendants. 2

In Equity No. 7025.

Testimony in behalf of the complainant for final hearing, taken at the office of Gifford & Bull, 141 Broadway, New York City, before R. B. Cavenagh, Notary Public.

New York, February 6th, 1905, 11 A. M.

Met pursuant to notice. Present: C. L. Sturtevant, Esq., and J. J. Healey, Jr., Esq., Counsel for 3 Defendant. Livingston Gifford, Esq., Counsel for Complainant.

Complainant's counsel offers in evidence the following documents:

1. Certified Copy of the patent in suit, being Letters Patent of the United States, to Donald 4 Cameron and others, No. 634,423, dated October 3, 1899, which is marked "Complainant's Exhibit Cameron Patent."

2. Certified copy of an assignment of said patent and others by Donald Cameron and others which is marked "Complaint's Exhibit, title paper, No. 1."

5 3. Certified copy of a second document in the chain of complainant's title to said patent, which is marked "Complainant's Exhibit Title Paper No. 2."

4. Certified copy of a third document in the chain of complainant's title to said patent, which is marked "Complainant's Exhibit Title Paper
6 No. 3."

5. Certified copy of a fourth document in the chain of complainant's title to said patent, which is marked "Complainant's Exhibit Title Paper No. 4."

6. Certified copy of a fifth document in the chain of complainant's title to said patent, which is marked "Complainant's Exhibit Title Paper No. 5."

7 7. Certified copy of a sixth document in the chain of complainant's title to said patent, which is marked "Complainant's Exhibit Title Paper No. 6."

Defendants admit that the construction and operation of the sewage disposal plant in use by them at Saratoga Springs, N. Y., from July, 1903, up to the
8 present time, is substantially correctly described in the article published in the Engineering Record, Vol. 51, No. 3, January 21, 1905, pages 82 to 86, entitled "Sewage Disposal at Saratoga Springs, N. Y.," a copy of which article is marked in evidence herein as "Complainant's Exhibit, Engineering Article on Saratoga Plant."

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Hubert D. Wyllie, a witness produced on behalf 10
of the complainant, being first duly sworn, testifies as follows:

Q. 1. Please state your name, age, residence and occupation? A. Hubert D. Wyllie; age, 51; residence, Chicago, Illinois; occupation, Sanitary Engineer and General Manager of the Cameron Septic
Tank Company. 11

Q. 2. What experience have you had qualifying you to testify as an expert in relation to the treating of sewage? A. I received a common school education in England, after which I was employed by my uncle to assist him in his business as a sanitary engineer, making a speciality of constructing
sewage and drainage systems. I acted as assistant 12
to my uncle in this business in all about eight years. I then came to the United States and was employed in railroading until 1899, the last fifteen years of this time I was chief clerk and assistant to the General Manager of the Chicago, Burlington & Quincy Rail-
road. During the last three or four years of this 13
time I had in contemplation returning to the profession of sanitary engineer and devoted my spare time in educating myself in that direction. Early in 1899 I made a trip to England for the express purpose of examining the operations of sewage disposal plants there, and particularly those constructed un-
der the Cameron system described in the patent in 14
suit. Ever since then I have devoted myself exclusively to the designing, construction and operation of sewage disposal plants under this system in the United States. I have devoted my attention not only to the practical part of constructing and operating sewage disposal plants, but have studied the

subject from a theoretical standpoint. I am now General Manager of the Cameron Septic Tank Company.

Q. 3. Have you examined and do you understand the specification and drawings of the Camer-
16 on patent No. 634,423, here in suit? A. I have
and do.

Q. 4. Have you also examined and do you understand the description of the construction and operation of the sewage disposal plant of the defendants herein, contained in "Complainant's Exhibit Engineering Article on Saratoga Plant," being the
article referred to in the admission by defendants
17 at the head of your deposition herein? A. I have
and do.

Q. 5. Have you also examined the sewage disposal plant operated by the defendants herein at Saratoga Springs, New York, and if so, when did your examination or examinations of the same oc-
cur? A. I made two examinations of the Sara-
18 toga Springs plant; the first on November 3rd, 1903,
and again on November 21st, 1904.

Q. 6. Were such examinations sufficient to enable you to understand and describe the construction and operation of that plant? A. Substantially so. Q. 7. What, if any communications did you have
19 with the defendant in regard to the Cameron patent
here in suit? A. Before the Saratoga Springs plant was commenced, that is, before the construction was commenced, I learned through the newspapers that it was in contemplation, and on April 3rd, 1902, I wrote the letter of that date, a copy of which I now produce and which is as follows:

"Chicago, April 3rd, 1902.

"Mr. H. F. Thomas,
Clerk Sewer Com'n,
Saratoga Springs, N. Y.

"Dear Sir:—

"I note in the engineering journals that a sewage-disposal system is proposed for your city, and desire to call your attention to the Cameron Septic 21
Tank System, briefly described in the pamphlet which is being sent you, under separate cover.

"The Cameron Septic Tank System has only recently been introduced into this country, but a complete installation was put down at Glencoe, Ill., last fall, which is doing remarkable work. A similar plant is now under construction at the Onwentsia Golf Club, Lake Forest, Ill., and will be in practical operation by May 1st. In addition 22
to these plants, installations have been put down at Vancouver, B. C., and Sackville, N. B., and in Great Britain 185 plants have been installed within the last three or four years, all of which are doing excellent work.

"Before deciding on a sewage-disposal plant for Saratoga Springs I would suggest a careful investigation of our System, and any additional information you may desire in regard to the matter I shall be glad to give you. 23

"Yours very truly,
(Signed) CAMERON SEPTIC TANK CO.
By H. D. Wyllie,
"General Manager."

I also produce and read the correspondence which followed:

"Sewer, Water and Street Commission, 24
Saratoga Springs, N. Y.

H. F. Thomas, Clerk.

April 7th, 1902.

"Cameron Septic Tank Co.,
No. 706 Plymouth Bldg.,
Chicago, Ill.

"Gentlemen:—

"We have already decided upon tanks, through the advisability of our engineers, Snow & Barbour, Boston, Mass., and any information regarding same may be had from them.

Respectfully,

(Signed) H. F. THOMAS."

"Chicago, April 9th, 1902.

26 "Mr. H. F. Thomas,
Clerk, Sewer, Water and Street Commission,
Saratoga Springs, N. Y.

"Dear Sir:—

"I am in receipt of your favor of the 7th inst., advising me that you have already decided upon tanks for your sewage-disposal plant, and referring me to Messrs. Snow & Barbour, Boston, Mass.

"The Cameron Septic Tank Co. has recently
27 secured control of the U. S. patents covering the septic tank process and apparatus, granted to Messrs. Cameron, Common & Martin, of Exeter, Eng., and it would perhaps be well to satisfy yourself that the system upon which you have decided does not conflict with those patents.

"A system recently installed at Plainfield, N. J., does conflict with those patents, and will probably be the subject of litigation in the near future.

28 "Yours very truly,

(Signed) CAMERON SEPTIC TANK CO.
By H. D. Wylie,
General Manager."

After the completion of the plant I examined it, as I have stated, on November 3rd, 1903, and at that time called on Dr. D. C. Moriarta, Chairman of the
29 Sewer, Water & Street Committee of Saratoga Springs, and gave him as the representative of the Village, verbal notice that the plant infringed the patent in suit.

Q. 8. What reply, if any, did he make to that notice, in substance? A. That it was a matter that he really knew very little about, but that if we supposed it to be an infringement, we probably knew what to do about it. That is in substance what he said.

Q. 9. Did you understand him to mean by that that he left you to substantiate your charge of infringement by suit? A. That is what I understood, as the gist of our conversation on the sub- 31
jec.t

Q. 10. What, if any, means have the owners of the patent here in suit adopted upon the sewage plants constructed under said patent, to notify the public that the said plants were patented under the patent here in suit? A. On all plants constructed under the Cameron patent, a name plate 32
is attached stating, among other things, "Patented Oct. 3, 1899."

Q. 11. Was there any difference in the construction or operation of the sewage disposal plant of the defendants between the times that you inspected it on November 3rd, 1903 and November 21st, 1904? A. None, that I could see. 33

Q. 12. How did the construction and operation of the defendants' sewage disposal plant, as you saw it at those times, compare with the description thereof contained in "Complainant's Exhibit Engineering Article on Saratoga Plant?" A. They were the same.

Q. 13. What means did you adopt in the course 34
of your examination of defendants' sewage disposal plant to ascertain the construction and operation of the same? A. I followed the course of the sewage from its entrance into the plant to its exit therefrom, opening manhole coverings from the apparatus so that I could see, examine its contents and

note the various stages of its operation. With a glass tube or guage which an attendant had on the premises, and which was thrust through the manhole down into one of the tanks in operation, I was able to remove and examine samples of its contents at
36 different levels, including the sludge at the bottom, the liquid at mid depth and the scum from the surface. I also removed and examined a sample of the effluent as it flowed from the septic tanks at the aerator. I also removed and examined sample of the effluent from the filter beds. One of the septic tanks not being in operation, I descended into it and
37 took the measurements of its sizes and the location and arrangement of the inlets and outlets.

Q. 14. Is there any substantial difference between the defendants' system of sewage, or the apparatus employed by the defendants therein, and the method and apparatus described in the patent here in suit. In answering this question, please
38 give a general outline of the system of each? A. No, they are substantially the same, both in method and apparatus. In both the sewage is subjected to the following successive operations:

First: To a settling operation adapted to permit any coarse mineral water, such as gravel or sand, to settle.

39 Second. To a septic operation in a septic tank, wherein the whole mass of solid organic matter in the sewage is liquefied; or, in other words, in which the liquefication extends throughout the whole mass of the sewage.

This is exclusively a bacterilogical operation and the bacteria by which it is accomplished are what

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are known as anaerobic, because they live or thrive
without air. The sewage on entering the tank is
distributed through a series of inlets separated
across the width of the tank at mid-depth and leaves
the tank through outlets at the opposite ends of the
tank also at mid-depth. On entering the tank, the
sewage moves bodily and slowly forward to the exit 41
at the opposite end of the tank, but in this move-
ment the solid particles of the sewage in suspension,
according to their specific gravity, rise to the sur-
face, or settle to the bottom, forming respectively
the scum and the sludge. I should have added that
the sewage enters and leaves the tank without agita-
tion. The scum forms a crust several inches in 42
thickness over the whole of the liquid in the tank
and acts as a complete excluder of air and light.
Air and light are also excluded by the covering of
the tank. The exclusion of air from the sludge and
the under surface of the scum presents the best con-
dition for the culture, life and activity of anaerobic
bacteria, and their location is such that they are 43
in the best position to operate on the whole mass
of sewage passing through the tank and liquefy it.
The liequefied effluent contains in solution this
liquefied organic matter, as well as some inorganic
matter in suspension, and probably also some or-
ganic matter which, though not liquefied in a theo-
retical sense, is so comminuted as to be liquefied for 44
all practical purposes with regard to the subse-
quent treatment to which the sewage is subjected.

Third: The next operation on the sewage is an
aerating operation, to which it is subjected in both
the patent in suit and in defendant's plant, by being
caused to flow in thin films over surfaces to which

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the air and light have free access. In defendant's plant this aerating operation is continued at the filters by being caused to be distributed on their surfaces in open channels exposed to light and air. In exposing the sewage to light and air, conditions are introduced favorable to the life and activity of
46 bacteria, known as aerobic, because they live with air, and this class of bacteria complete the work of purification commenced by the anaerobic bacteria in the septic tanks. The action of aerobic bacteria is frequently referred to as an oxidizing action.

Fourth: The sewage is next subjected to the action of the filter beds, from which it is discharged
47 finally purified.

Recess until 2:30.

Q. 15. "Complainant's Exhibit Engineering Article on Saratoga Plant," stated as follows on January 31st, 1905:

"The tanks have never been emptied since they were put in service in July, 1903, and no solid matter has been taken from them * * * * *
48 * * Septic treatment was begun in the summer at the time of maximum population, the result being a rapid accumulation of solids during the first two months. * * * * * * The depth of the scum and the deposit continuously increased up to April, 1904, when about 44 per cent. of the entire volume of the tank was occupied by these accumulations. * * * * * * In August, when the sewage had reached its max-
49 imum temperature of 70° Fahr., the per cent. volume occupied by the scum deposit had fallen to 21.4 per cent. Since then the temperature has lowered, and accumulated solids on Jan. 1, 1905, occupied about 25 per cent. of the volume."

How does an apparatus constructed and operated as described in the Cameron patent in suit, compare in its results with the description I have just quoted

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of the operation of defendants' apparatus? A. I should say the result would be very similar.

Q. 16. Will you please explain why it is that the results of the use of the defendants' apparatus and the apparatus of the patent in suit, show an increase of the scum and deposit at the commencement, and thereafter no further increase, but rather 51
a diminution? A. The reason for this is, that the defendants' plant was put in operation rather late in the Summer, when the population was nearly at its maximum. It takes several weeks for the cultivation and development of anaerobic bacteria, even under most favorable conditions, and before this development was complete cold weather set in and 52
it is a well known fact that the action of anaerobic bacteria is affected by the temperature, being very much slower in a low temperature; the natural result then is that the accumulations in the tank would increase. Later, when bacterial activity is more complete, there is a marked diminution in the solid matter in the tank, notwithstanding the fact 53
that it had been constantly added to by the continuous flow of sewage from the Village.

Q. 17. As I understand you, then, the results above alluded to are due to the fact that the scum and sediment have to accumulate for a period which, under the most favorable conditions, would occupy several weeks before sufficient anaerobic 54
bacteria will be cultivated in the under surface of the scum and in the sediment to take care or dispose of the solid organic matter constantly entering the tank, after which, allowing for variations in temperature, the increase of the scum and sediment will substantially cease?

Question objected to as grossly leading.

A. That was my meaning.

Q. 18. Have you made a drawing, or caused one to be made, substantially representing the defendants' sewage disposal plant at Saratoga Springs, New York, inspected by you
56 at the times you referred to, and if so, will you please produce the same? A. I produce a blue print of a drawing which was prepared from notes I made during my examinations of the defendants' plant.

Q. 19. Does this blue print substantially represent the defendants' plant as it stood at the time
57 examined by you? A. It does.

Complainant's counsel offers in evidence the blue print just produced and the same is marked "Complainant's Exhibit Blue Print of Saratoga Plant."

Q. 20. Please describe the construction of the defendants' sewage disposal plant, in connection
58 with this blue print, as it stood at the time you inspected it. In giving this description, please use on the blue print, letters and numerals corresponding with the letters and numerals by which corresponding parts are designated in the drawings of the Cameron patent in suit, and wherever the language of the Cameron patent in suit correctly
59 describes the construction of the defendants' plant, please adopt such language and quote the same from the patent in your description of the defendants' plant. A. I do so, as follows. I now quote from line 40, page 2, of the Cameron patent in suit.

"Fig. 1 represents a sectional plan view of a tank for use in the treatment of sewage. * * *

* * * Fig. 2 represents a longitudinal section on the line 2—2 of Fig. 1. Fig. 3 represents a transverse section on the line 3—3 of Fig. 1.''

Fig. 4 represents a transverse section on the line 4—4 of Fig. 1.

I now quote from line 66, page 2 of the patent in suit. 61

''A, being the tank which is constructed of * * * * * cement concrete. It is shallow in comparison with other dimensions and is provided with a cover 60 which is * * made air tight and * * * man * * * holes 61 are provided in such cover * *''

I now quote from line 81, page 2:

''The inlet 63 to the tank discharges into same 62
some distance below the normal water level and is * * * * directed horizontally * * * so as to avoid breaking the scum which forms in the tank when sewage has been in it for two or three days. The outlets from the tank is submerged * * * In the upper half of the depth of the tank and is extended across the * * * greater part of the width of the tank so as to draw off the clear water below the scum or floating mat- 63
ter without disturbing the latter. It is necessary to discharge the contents of the tank or vessel along an extended line lest the flow should be concentrated to a point or points of discharge and so disturbed and carry away the floating matter. The outlet therefore consists of a * * * conduit 10 * * * following the line along which it is desired that the contents of the vessel or tank A should be discharged and having throughout its 64
length''
an ''aperture by which liquid may enter the said * * conduit.''

This aperture consists of two inch holes in two horizontal rows lettered 10a in the blue print about three and a half feet from the surface, and constitutes the substantial equivalent of a slot, es-

65 pecially if this slot were provided with a strainer for the exclusion of solid matter as the patent in suit states it may have (see p. 2, line 121).

I next quote from line 128, page 2, of the patent in suit:

There are "two or more tanks * * * so
66 that any of them may be emptied if necessary without interrupting the purification of the sewage."

I now quote from line 132, page 2 of the patent in suit:

There is "means for the removal of mud or other material deposited * * * for which purpose the bottom of such tank or vessel * * * (is) sloped toward * * * a pipe or conduit 11."

67 I now quote from line 25, page 3 of the patent in suit:

"In the arrangement shown in Figs. 1, 2 and 3
the sewage or other liquid coming through the
sewer 13 is delivered into a well 14, where grit and
other solid matters are allowed to settle. It then
passes through the pipes 15 and 16 and the inlets
63 into the tank A in which it may be treated *
* * bacteriologically. * * After treatment
68 in the tank A it passes into the pipe or conduit
10 through the * * *apertures provided for the
purpose, the effect of which is that it is evenly de-
livered all along the line of the * * * open-
ings into the * * * conduit and concentration
of the flow to one or more points is avoided. From
the * * conduit 10 the effluent passes through
pipes 17 * * * into the aerator 18 * * *
down which it flows in thin films * * * this
69 operation being repeated until it arrives at the last
compartment whence it * * * (is) conveyed
through pipes 66 to a filter or filters for further
treatment. It will be seen that as the effluent passes over the inclined surface 65 it will be exposed to the action of the air and so aerated."

67 is a dosing tank connected by the pipe 66 with the sand filters 69.

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Q. 21. As I understand it, your last answer is a description in connection with the blue print which you have produced of the defendants' sewage disposal plant; those portions of the answer in quotation marks being quoted from the specification of the Cameron patent in suit; is that correct? 71

Same objection.

A. It is.

Q. 22. Now, please describe in connection with the blue print of the Saratoga plant, how the defendants operate said plant? A. The method of operating the defendants' plant resembles so closely the processes described in the Cameron 72
patent in suit, that I can not describe it better than in the language of the specification of the patent in suit, which I will now do, placng in quotations those portions of my description which I quote from the said specification.

I will now quote from page 1, line 51 of the patent: 73

"In carrying out the process the first step is to develop in a flowing current of sewage micro-organisms or bacteria of a character and quantity capable of practically liquefying the mass of solid organic matter contained in the flowing current of sewage. This is effected by forming a pool in the flowing current and secluding said pool from light, air and agitation while permitting a non-disturb- 74
ing inflow of the sewage into the pool," from the inlet opening 63, "and an outflow therefrom" from the openings 10a. In this condition of the pool, in the absence of light, air and agitation, the micro-organisms increase at a fabulous rate, being fed by the incoming solid matter of the sewage until a mass of bacteria is developed sufficient in character and quantity to liquefy substantially all the

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solid organic matter contained in the sewage passing through the pool. During this operation there is formed on the surface of the sewage in the pool a brown scum. This crust of solid substances floating and completely bridging over the water is (several) * * inches thick * * *"

I will now quote from the specification com-
76 mencing with line 81, page 1:

* "After the formation of this practical solid dissolving mass of bacteria, the non-disturbing inflow and outflow are continued until practically all the solid organic matter is dissolved and the outflow is in the form of a liquid without solid particles of sewage. The operation goes on and the flowing current of sewage is continually liquefying. The liquefied sewage as it leaves the septic
77 pool has a slight odor * * * and to relieve it of this slight odor it is subjected to an aerating operation."

There is no chemical treatment of the sewage. The process is exclusively bacteriological and is accurately and literally described in claims 1, 2, 3, 4 and 21 of the patent in suit.

78 Q. 23. I have carefully compared with the specification of the Cameron patent in suit the quotations therefrom that you have given in your last two answers as correctly descriptive, in connection with your blue print, of the defendant's apparatus, and its process of use, and it appears to me that the principal parts of the specification
79 that you have omitted to quote are the parts descriptive of alternative constructions, or merely words of preference. I therefore ask you whether you understand that the quotations of your last two answers include substantially all of the important parts of the specification of the Cameron patent in suit descriptive of the form of apparatus

therein described as preferable and its process of operation?

Objected to as leading and manifestly an attempt to suggest to the witness.

A. They are substantially so.

Q. 24. Turning now to the process claims 1, 2,
3, 4 and 21, of the patent in suit, state whether 81
the process of treating sewage employed by the
defendants and heretofore referred to by you, con-
tains the invention particularly specified in said
claims respectively, or either of them, and give
your reasons for any opinion you may express. A.
It does as to each and all of said claims. This
opinion is based on the manifest fact that the 82
language of each of said claims describes literally
the process carried on in the defendants' plant,
and that therefore not only is the same result ac-
complished, but in precisely the same way as de-
scribed in each and all of the said claims.

Q. 25. Turning now to apparatus claims, 5, 6,
7, 8, 11, 12, 20 and 22, of the Cameron patent in 83
suit, please state whether you find the invention
specified in said claims respectively, or either of
them, contained in the apparatus of the defend-
ants' plant before referred to by you, and repre-
sented in your "Exhibit Blue Print Saratoga
Plant," and give your reason for any opinion you
may express? A. I do, as to all of the claims 84
mentioned. Claims 5, 6, 8, 11, 20 and 22, are each
literally descriptive of the defendants' apparatus.
Claims 7 and 12 are also descriptive of defendants'
apparatus, but with the exception that the outlets
are referred to as a slot. In defendants' plant this
aperture consists of two horizontal rows of holes

85 10a, extending across the entire width of the tank and constitutes the mechanical equivalent for a slot and is especially so if such slot were provided with a strainer, as is stated on lines 121, 122, 123, page 1 of the specification, as follows:

"The slot or apertures may also be provided
86 with a strainer for the exclusion of solid matter."

Q. 26. Is this outlet from defendants' tank, and which you say is the mechanical equivalent of the slot of the claims, the same which is described in Exhibit Engineering Article on Saratoga Plant, as follows:

"The septic effluent is discharged at the opposite end through 96 2-in. pipes, in two horizontal
87 rows, also 3½ feet below the high water line * * * extending the width of the tank."

A. It is.

Q. 27. "Exhibition Engineering Article on Saratoga Plant" gives the depth of the sewage at the inlet end of the tank as 7¾ feet and at the outlet end as 8¼ feet, and states that the four
88 inlet openings for the sewage are at a depth of 3½ feet below high water line, and that the outlet openings are also at 3½ feet depth. Are these the depths that you referred to as mid-depth? A. Yes. In other words, both the inlets and outlets are about four feet from the bottom of the tank.

Q. 28. What position were these inlets and out-
89 lets in with respect to the scum on top and the sediment or sludge at the bottom of the tank? A. Between the two.

Q. 29. The exhibit "Engineering Article on Saratoga Plant" states that there are four of these septic tanks in defendants' plant, each 91½ feet long by 51½ feet wide. Are the sewage inlet and outlet openings respectively at tthe opposite ends of each of these tanks, so that the mass of sewage flows lengthwise through an oblong tank as it does in the patent in suit? A. They are.

Q. 30. Is it also true that the inlet and outlet openings being distributed across the respective
ends of the tank cause the mass of sewage to flow 91
bodily through the tank from end to end in a current which extends substantially equably across the tank and between the scum above and the sludge below, in both the defendants' apparatus and that of the patent in suit? A. It is.

Q. 31. What is the material in the defendants'
plant that is numbered 80 in "Complainant's Ex- 92
hibit Blue Print Saratoga Plant" and which overlies the roof of the septic tank A, A. Earth filling.

Adjourned to Tuesday, Feb. 7th, 1905, 10.30 a. m.

New York, February 7th, 1905, 10.30. 93

Met pursuant to adjournment;

Present, counsel as before.

Examination of Mr. Wyllie continued:

Q. 32. In describing the defendants' process in the language of the Cameron patent in suit, you used the expression "forming a pool in the flowing
current and secluding said pool from light, air and 94
agitation," and you added, that under these conditions, "the micro-organisms increase at a fabulous rate, being fed by the incoming solid matter of the sewage until a mass of bacteria is developed sufficient in character and quantity to liquefy substantially all the solid organic matter contained in the

sewage passing through the pool;" such bacteria finding their lodgement and being cultivated in the sediment or sludge, and the scum below and above the flowing current of sewage. About what is the speed of defendants' flowing current of sewage under which these conditions are maintained. In
96 answering this question you may avail yourself of any data given in Exhibit "Engineering Article on Saratoga Plant." A. The speed of the sewage through the tank would be about from six to nine feet per hour. This calculation is based upon the statement in the Engineering Article referred to, that the daily flow of sewage is retained in the tank
97 from ten to fifteen hours.

Q. 33. What provision is made in connection with the defendants' septic tanks for maintaining the depth of the sewage therein substantially constant and what provision is made in the Cameron patent in suit for like purpose? A. The depth of sewage in the septic tank in defendants' plant is
98 maintained by the level of the weir, over which the tank effluent is discharged from conduit 10 shown in Figure 2 longitudinal section, on line 2—2, Fig. 1, of the "Complainant's Exhibit Blue Print Saratoga Plant." In the Cameron patent, the depth of sewage in the tank is maintained by the level of the aerator or slightly sloping surface 65, shown in the
99 drawings of the patent in suit.

Q. 34. In the Exhibit "Engineering Article on Saratoga Plant," the cut entitled "Interior View of Septic Tank Looking Toward Outlet End, shows the roof as supported by pillars, which pillars are not represented in your blue print; why is this? A. The pillars shown in the cut referred to are for the purpose of supporting the roof of the plant, and are not essential so far as the process is concerned. They were therefore omitted from the blue print to avoid confusion.

Q. 35. Does the cut referred to show the double
line of mid-depth performations that constitute the 101
outlet for the tank effluent, and which you have
designated by 10-a in your blue print? A. Yes, it
does. These perforations appear in the end walls
of the cut referred to, although somewhat indis-
tinct.

Q. 36. As I understand you, the defendants in
the use of their septic tanks, introduce nothing into 102
the tank excepting the sewage itself; is that cor-
rect? A. It is.

Q. 37. In the Engineering Article, it is stated
that in the defendants' tanks the depth of the sew-
age at the inlet end is 7¾ feet, and at the outlet
end 8¼ feet; is this because the floor of the tank is
slightly inclined downward from the inlet end 103
towards the outlet end? A. It is.

Q. 38. What is the size of each of the four inlet openings into defendants' septic tank, which you have numbered 63, on your blue-print? A. Each is 12 inches in diameter.

Q. 40. About how far are they spaced apart
across the end of the tank? A. About 12 feet, or 104
possibly 13 feet apart.

Q. 41. Do the arrows on your blue-print show the course taken by the sewage during its treatment by defendants? A. They do.

Q. 42. Why have you designated the pipe 81 on your blue-print as "distributing pipe?" A. Because its function is the distribution of the sewage supply to the different tanks.

Q. 43. Explain more particularly than you have done the connections by which the sewage supply is distributed from the pipe 81 to each of the different tanks? A. The sewage is discharged through pipe
106 81 into an inlet chamber 81-a, which is divided into two compartments by a dividing wall, the top of which is 9 inches above the maintained water level. In this wall there is an opening controlled by a valve which when open allows the sewage to flow through it into an inner chamber. From each side of this inner chamber, pipes 15 and 16 lead to the
107 septic tanks and the sewage is discharged into it through inlets 63.

Q. 44. In the operation of defendant's apparatus, was the pipe 11, which on your blue print is called "pipe to sludge bed," open or closed? A. It was closed.

Q. 45. Describe more particularly than you have
108 done the connections between the tank outlet holes 10-a and the pipe 17, called on your blue print "pipe to aerator?" A. The outlet holes 10-a open into a conduit 10, extending the entire width of the tank, and the sewage flowing through these holes passes through conduit 10 and over a weir, by which the water level in the septic tank is main-
109 tained, into a weir chamber, shown on the blue print. Thence to the outlet chamber, as shown by arrows, from which it is discharged into pipe 17.

Q. 46. Is the weir chamber covered or uncovered? A. It is covered, access thereto being through a manhole.

Q. 47. Explain more in detail than you have

done, the defendant's aerator, shown in your blue print? A. The aerator is a circular chamber having in its center a riser pipe which at the bottom is connected with pipe 17. The sewage flowing through pipe 17 rises to the top of this central riser pipe and overflows passing in thin films over and
through perforated surfaces into the body of the 111
circular chamber 18 before referred to; thence to the dosing tank.

Q. 48. In the Exhibit Engineering Article, is the flowing of the sewage over the top of the central riser pipe in a thin film over the upper perforated plates 65, shown in the cut entitled "aerator on the
discharge pipe of the Saratoga Springs septic 112
tanks?" A. It is.

Q. 49. Is there any substantial difference in the mode of operation of this aerator, or the result accomplished thereby, upon the septic effluent from the septic tanks, from the mode of operation and result of the aerator of the Cameron patent in suit,
wherein the septic effluent from the septic tank is 113
caused to flow in thin films over the successive surfaces three of which are shown and numbered 65 in the drawing of the patent in suit? A. No, there is no substantial difference. In both the defendant's plant and the patent in suit, the sewage is caused to flow in thin films over surfaces to which air and
light have free access. 114

Q. 50. As I understand it, there is no cover or top over the defendants' aerator; is that so? A. It has no cover.

Q. 51. Explain more particularly than you have done, the function of the defendants' dosing tank, numbered 67 on your blue print? A. The dosing tank 67 is a receptacle in which a certain quantity of sewage is temporarily retained for distribution alternately through pipe 66 to the sand filters 69. It is fitted with an apparatus for this alternate distribution.

Q. 52. Is this dosing tank of the defendants
116 roofed over? A. It is.

Q. 53. I come now to the defendants' filter beds, of which the Engineering Article states that there are 20, and that 18 of them are about one acre in size, and the other two somewhat smaller. As I understand it, in Figure 1 of your blue print you have shown one of these filter beds, and a portion
117 of the two adjoining it on either side, designated as "sand filter 69;" is that correct? A. Yes, it is.

Q. 54. And I also understand that on your blue print you have shown only the connection between the dosing tank and one of the filter beds? A. That is correct.

Q. 55. But I also understand that the dosing
118 tank is in fact connected with each of the other filter beds by pipes not shown in your blue print?

Objected to as leading.

A. I presme so.

Q. 56. You have stated (Ans. 14) that the sewage is distributed on the surface of defendants'
119 filters in open channels exposed to light and air. Is one of those channels shown on your blue print extending across the filter bed 69? A. It is, and marked "Main distributing channel."

Q. 57. What, if any other channels are there on the surface of the filter beds through which the sewage is distributed over the surface of the bed

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while exposed to light and air? A. The surface of the beds is trenched.

Q. 58. Are the "Main distributing channel" and the trenches that you have referred to, by which the sewage is distributed over the surface of defendant's beds, and at the same time subjected to light
and air, shown in the cut of the Engineering 121
Article, entitled "Intermitted Sand Filtration Beds at Saratoga Springs?" A. They are.

Q. 59. Is the under drainage of the defendants' filter beds, and which you have illustrated in your blue print by the "Collecting Pipe," that which you understand to be described in the Engineering
article as follows: 122

"Only one line of under drains was laid under each bed at a depth of about 6½ feet, and a line of 10 to 15 inch drains was placed at a depth of 11 feet, and the smaller drains connected with it. In the main drain manholes were placed at the junction of the laterals and the upper ends of all drains were turned up and carried to the surface in order to induce a circulation of air and reduce
the accumulation of carbonic acid gas in the body 123
of the filters."

A. Yes, it is; but having no means of ascertaining just what method of under-drainage was adopted in the defendants' plant, at the same time knowing that some such method was essential, I placed the collecting pipe i nthe drawing as shown, for the
purpose of indicating the probable method of under- 124
drainage that might reasonably be supposed was adopted.

Q. 60. Is any chemical added to the sewage, or permitted to act upon the sewage, at any stage of the defendants' treatment? A. No; there are manifestly no chemicals used, as their introduction

125
would interfere with the operation of the system,
which is admittedly bacteriological, or, in other
words, septic.

Q. 61. Did you examine the final sewage effluent
from the filter beds of the defendants' plant, and if
so, what did you find as to the result upon the sew-
126 age of such plant, and the comparison of such
result with that accomplished by a plant construct-
ed and operating as described in the Cameron pat-
ent in suit? A. I removed a sample of the effluent
from the filter beds and examined it. The result
was substantially the same as what might be ex-
pected from a plant built under the Cameron pat-
127 ent which is in suit. The purification of the sew-
age was substantially complete.

Q. 62. Was such result substantially the same
as that which you have found to be produced by
plants constructed as described in the Cameron
patent in suit? A. Substantially so.

Q. 63. Did you also examine the sewage effluent
128 in the defendants' plant at the stage intermediate
the septic tank and the aerator, and if so, what did
you find as to the result up to that stage upon the
sewage of the defendants' plant in comparison with
the result up to a corresponding stage accomplished
by plants constructed as described in the Cameron
patent in suit? A. Yes, by removing the manhole
129 coverings from the weir chambers and outlet cham-
ber, shown in the blue print drawing of the defend-
ants' plant, I was able to see the sewage passing
through them, and although I did not remove
samples its general appearance was similar to a
tank effluent from septic tanks built in accordance
with the Cameron patent in suit.

HUBERT D. WYLLIE. 130

Q. 64. Did you inspect the scum on the top of the
sewage in the defendants' septic tank, and if so,
how did such scum compare with the scum formed
on top of the sewage in the operation of a plant con-
structed in accordance with the description of the
patent in suit? A. I did examine it, and as already
stated in my testimony, removed samples. Its ap- 131
pearance in all respects was similar to the scums
which form on septic tanks built in accordance
with the Cameron patent, which had been in opera-
tion for about the same length of time.

Direct examination closed.

New York, February 8th, 1905, 10:30 A. M. 132

Met pursuant to adjournment.

Present, counsel as before.

Cross-examination of Mr. Wyllie by Mr. Sturte-
vant:

XQ. 65. In what capacity were you employed by
your uncle during the period spoken of in your
answer to Q. 2? A. I was employed as assistant 133
to my uncle, Mr. John M. Martin, civil and sanitary
engineer, at Exeter, England. I did a good deal of
field work as well as assisting in the plotting, sur-
veying and similar work, incidental to the business.
Also inspected works after completitition. My uncle,
John M. Martin was the father of Arthur J. Martin,
one of the patentees of the patent in suit. 134

XQ. 66. During the time you were employed by
your uncle, did you have any special experience in
the constructing of sewage disposal systems, and if
so, state generally what experience you had? A.
The only sewage disposal systems that I can recall
having been engaged upon, was that at Ruabon, in

North Wales. In this case I was not employed in
the field work, but assisted in the office.

XQ. 67. Can you give a general idea of the meth-
od of operation of that sewage disposal system and
the size of the plant, &c? A. I can, in a general way.
In the sewage disposal plant of which I speak, we
136 disposed of the sewage of the City of Ruabon on
a sewage farm of about 200 acres, the farm being
divided up into sections, and each section receiving
the sewage at different times, the farm being culti-
vated, and the work of construction, I might say,
comprised the laying out of this farm, the irrigation
ditches, drainage, &c. There was no preliminary
137 treatment of the sewage.

XQ. 68. As I understand, you were not in this
particular work at Ruabon employed in the field,
but in the office, designing, working up notes, &c.;
but did you have in other cases actual field experi-
ence in the laying of sewerage systems, and work of
that character? A. I did.

138 XQ. 69. But this was the only complete system
of sewage disposal upon which you performed any
work at the times mentioned, was it, during the time
you were in the employ of Mr. Martin? A. It is
the only extensive system, we were employed on
during that time. The only other sewerage systems
that I worked on emptied directly into tidal waters
139 or into streams, without any preliminary treatment
or method of disposal.

XQ. 70. In your answer to Q. 2, you have stated
that you have devoted yourself exclusively the past
few years to the designing, construction and opera-
tion of sewage disposal plants under the Cameron
system in the United States. Please state where in

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this country such plants have been constructed by your company? A. The first plant we were engaged on in this Continent was in Sackville, New Brunswick; and the next was at Vancouver, B. C.; Glencoe, Illinois; Clayton, Missouri; a small plant at Lake Forest, Illinois; a plant at Davenport, Iowa
(this was for a public institution, with a popula- 141
tion of about three or four hundred); Mt. Pleasant, Iowa; Cambridge, Illinois; Chickamauga Park, Georgia (a military post); Moline, Illinois; Grand Canyon, Arizona; another plant at Lake Forest (in a ladies' academy); and others, of which I will furnish a list, if you wish.

XQ. 71. Were any of these sewage disposal 142
plants which you have mentioned, constructed for the purpose of taking care of the sewage of the entire towns, or only of institutions, independent houses, and the like? A. They were either for towns or institutions. At Glencoe, we disposed of the sewage of the entire town, I think about 1200 population. At Vancouver we have taken care of 143
the sewage of a population of about 10,000, at three different locations; that is, we have three plants. And the others are for portions of towns, or for institutions with populations up to, say, 2500. For example, at Clayton, Missouri, a plant which we constructed there, takes care of the sewage from the County buildings, the jail, and a portion of the 144
town. The sewage of a portion of the town has been carried into the plant since.

XQ. 71. But so far as these plants, which you have mentioned, are concerned, did you yourself design the construction of the same? A. They were either designed by me or under my supervision.

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XQ. 72. What do you mean by under your supervision—by engineers or draftsmen in the employ of your company, or by engineers of the towns or institutions working under advice from you? A. By engineers or draftsmen in the employ of my company.

146 XQ. 73. What are the largest and the smallest plants of this character, which your company has constructed? I mean by the "largest," to use the term with reference to the population that the plant has been designed to look after?

In order to avoid misapprehension, complainant's counsel requests the witness
147 in his answer to state whether he refers only to the American Company or to the British Company.

A. Referring only to the plants constructed by the American Company, the largest would be the Vancouver plant, where each plant takes care of 5000, 3000 and 2000 respectively. This was put in
148 in the Winter of 1900 and 1901, I think, from plans and specifications furnished by this company, or by me personally, before the organization of the Cameron Septic Tank Company. The smallest would probably be a plant designed for a large ranch house near Trinidad, Colorado, where, if I remember correctly, the population to be provided for was
149 about 20 or 30.

XQ. 74. Are all of these plants, to which you have referred in successful practical operation at the present time? A. They are, with the possible exception of a plant here and there that has not received proper attention. I mean by this, that the plants designed by us require so little attention,

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that what little attention they need is often times neglected. This refers more particularly to the contact beds, and the care of the alternating gear by which the tank effluent is distributed to them.

XQ. 75. Can you mention any of these plants which you have knowledge are not in successful
operation at this time? A. No. I believe at this 151
time they are all in good practical working order. The last complaint I received was about a couple of weeks ago from the Davenport plant, this complaint gave no particulars, but said it needed attention. I sent a man there to look at it, and he reported that the contact beds seemed to be clogged.
This was due largely to the inferior quality of the 152
material with which the beds are filled. In building the Davenport plant we used cinders produced at the institution, which to all appearances were suitable for the purpose, but we found later that although these cinders were carefully screened, they contained a good deal of unconsumed coal and ash
which after frequent saturation became disintegrat- 153
ed and clogged the interstices of the filtering material. This has given us a good deal of trouble, and is the cause of this particular complaint I speak of. The septic tank in this and other cases has worked satisfactorily.

XQ. 76. Leaving out of consideration the
Canadian plant, what is the largest plant you have 154
constructed in the United States, and for how large a population does it look after? A. At Moline, Illinois. Our plant there is designed for 2500. I think that is the largest.

XQ. 77. Are all these plants, both the large and small, constructed substantially in accordance with the specifications and drawings of the Cameron patent in suit? A. Substantially so, with certain modifications made necessary by local conditions.

XQ. 78. How large about would be the septic tank in the smallest plant you have referred to?
156 That is, to look after 20 to 30 persons? A. I can't state the dimensions from recollection, but I can figure them out approximately, if you wish. Approximately 12 feet long and 5 feet wide.

XQ. 79. Can you remember substantially the dimensions of the septic tank in the plant at Moline, Illinois? A. The plant at Moline consists of
157 two septic tanks and two sets of contact beds. Each of the septic tanks, I think, are about 80 feet long and about 12 or 14 feet wide.

XQ. 80. In both the large and the small plant referred to, does the sewage pass into a settling chamber before going into the septic tank? A. Yes.

158 XQ. 81. In the large plant at Moline, do you use the system of aeration set forth in the Cameron patent in suit; if not, how do you aerate? A. Not exactly; for the reason that we had so little fall that it made it impractical. We therefore depend on aeration in this plant in the contact beds themselves.

159 XQ. 82. I understand, then, that you aerate on the filter beds in the Moline plant; is that correct? A. In the contact beds.

XQ. 83. Will you please explain how this aeration is accomplished in the Moline plant in the contact bed? A. To do so I had better perhaps describe the contact bed. The function of a con-

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tact bed is to hold the tank effluent in contact with the material with which the bed is filled. When full of sewage it is allowed to remain full for a certain length of time and then by an automatic arrangement it is discharged, and as it leaves the contact bed the air is drawn down into the body of the filter, preparing it for its next dose 161
of sewage.

XQ. 84. As I understand it, then, a contact bed is a filter bed, although a filter bed need not necessarily be a contact bed; is that true? A. That is right.

XQ. 85. The aeration, then, at Moline is simply 162
what naturally takes place in the use of a contact bed; is that correct? A. Yes. We would prefer to use an aerator, but as I have before stated, the local conditions would not permit it.

XQ. 86. Still you consider that in the Moline plant there is and must be aeration of the effluent from the septic tank; that is correct, is it not? A. 163
To a limited extent.

XQ. 87. So far, then, as the process of aeration mentioned in the patent is concerned, it is immaterial whether this aeration takes place at exactly the time stated in the patent, or at the time it takes place in the Moline plant; that is correct, is it not? A. No; hardly immaterial; I wouldn't 164
say immaterial, because I think better results are secured by subjecting it to a distinct aerating operation when it leaves the septic tank, and before entering the contact beds.

XQ. 88. Still you consider the aeration in the contact bed of the Moline plant a mixing of the sewage with the air to purify the effluent to a certain extent, do you not? A. Yes, I do.

XQ. 89. Please explain how the aeration of the effluent is accomplished in the small plant near Trinidad, Colorado, to which you have referred?
A. I don't remember the details of that plant. It
166 was designed a long time ago.

XQ. 90. You remember, however, do you not, there was provision made in this plant for aeration of the effluent? A. I presume so, but I don't remember the details.

XQ. 91. In that small plant was the effluent
167 delivered from the septic tank to filter beds? A.
Yes, I remember that part of it, because I remember furnishing the necessary alternating gear for its distribution to the contact beds

XQ. 92. Without regard to details, however, can you not say positively whether or not there was provision made in this small plant for aera-
168 tion? A. I can not, further than that it would
receive in the contact bed. As I have before stated, I don't remember the details of its construction.

XQ. 93. Have you ever constructed a plant in which there has been aeration of the effluent, except in the contact or filter bed? A. Yes, sir; at
169 Mt. Pleasant, Iowa, for instance.

XQ. 94. Did you ever see that small plant near Trinidad? A. No, sir. I merely furnished the design; that is, the plans and specifications for its construction.

XQ. 95. Will you ascertain how the aeration was accomplished in this small plant near Trini-

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dad? A. I shall be glad to do so. I have telegraphed for the plans.

XQ. 96. Referring to the Moline plant, please explain how the sewage is passed from the settling chamber into the septic tank. A. In the settling chamber we have two valves connecting with distributing chambers at the intlet end of each 171
of the tanks; from these inlet or distributing chambers, the sewage is passed into the septic tanks.

XQ. 97. Is it passed into the septic tanks in the manner illustrated in the patent in suit? A. Substantially so; we have a series of inlets into each tank, discharging at mid-depth in the tank. That is, between the scum and the sludge. 172

XQ. 98. Is the manner of passing the effluent out of the septic tank substantially like that shown in the Cameron patent in suit, or if different, how does it differ? A. It is the same.

XQ. 99. While perhaps you cannot remember all the details of the various plants you have designed and constructed, is it not so that in all of 173
them some provision was made for aeration of the effluent? A. That is true whenever we have sufficient fall for that purpose. Unfortunately it happens sometimes, as at Moline, where we have to depend on the aeration to which the effluent is subjected in the contact bed.

XQ. 100. Still in all cases there is aeration? A. 174
Yes.

XQ. 101. Do you remember as to the small plant near Trinidad, Colorado, how the sewage passes from the settling chamber into the septic tank? A. I do not. But I think it is safe to say that it is discharged into the tank substantially

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the same as at Moline, or substantially the same as into each one of the tanks at Moline.

XQ. 102. Do you remember as to the discharge of the effluent from the septic tank at the small plant referred to? A. I do not. I never saw the plant and have only an indistinct recollection of
176 its construction, or design.

XQ. 103. I think you said in answer to one of the questions on direct examination, that you attach a plate with the Cameron patent date to the tanks of the apparatuses which you instal. I suppose you carry out this plan upon the large as well as the small plants, do you not? A. We do. If
177 not on a name plate specially provided for that purpose, it appears on the iron manhole covers with which all of the plants, large or small, are provided.

XQ. 104. You consider, then, that so far as the process of the patent in suit is concerned, and also so far as the general construction of the apparatus
178 is concerned, that a plant of small size, as well as a plant of large size, comes within the purview of the patent in suit; that is correct, is it not? A. It is.

Recess until 2 p. m.

The witness states that he desires to add at the end of his answer to Q. 71 the words "or is con-
179 templated."

XQ. 105. Did you yourself superintend the construction of the plant at Moline, Illinois? A. Not personally; the contract for the actual construction of the Moline plant was let to a man who has had considerable experience in the construction of our plants, that is, he has constructed several of them.

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His name is F. G. Mortimer, of Chicago, and the construction of the plants which he builds for us are directly under our supervision.

XQ. 106. Have you ever personally examined the plant at Moline, Illinois? A. Yes, both during construction and afterwards, several times during construction. 181

XQ. 107. Do you know how long this plant has been in operation? A. A little over a year.

XQ. 108. Have you made an examination of this plant since it was in operation? If so, when? A. The last time I saw it I think was in the early part of this winter.

XQ. 109. Do you remember about how much of a 182
sludge formation there was at that time? A. I do not. I didn't examine it. My object in visiting the plant was to see that it was operating satisfactorily, and to all appearances it was.

XQ. 110. Do you know whether or not there had been or has been, any removal of sludge during its operation? A. There has not. 183

XQ. 111. But you don't remember how much of this sludge deposit there was at the time you visited the plant last, do you? A. No. There certainly was not enough of an accumulation to interfere with its operation or it would have been apparent in the tank effluent.

XQ. 112. You have referred in your answer to 184
XQ 93 to a plant at Mt. Pleasant, Iowa, in which there has been aeration of the effluent, other than in the contact or filter bed. Will you please explain the system of areation in use in that plant? A. Yes; the aerator consists of a chamber 8 or 10 feet long, about 18 inches or two feet wide, and about

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2 or 3 feet deep. The tank effluent leaving the sep-
tic tank is discharged into this aerating chamber
through an upright pipe which is built up through
the bottom of a trough extending the whole length
of the aerating chamber. The effluent flows over
the top of this pipe into the trough, overflowing
186 the sides of the same its entire length in thin films
into the body of the aerator, from which it is con-
ducted to the alternating arrangement for distrib-
uting the flow on to the contact beds.

XQ. 113. As I understand it then, the effluent
passes through a closed pipe into a trough and when
the trough is filled the effluent flows over the edge
187 in a thin film into the aerating chamber, is that
correct? A. It is correct, except that the pipe is
not enclosed; it overflows over the top of the pipe
into the trough, and from the trough into the cham-
ber.

XQ. 114. Is this plant at Mt. Pleasant, as you
remember, the only one in which that particular
188 system of aeration has been adopted? A. No; the
same system is adopted at Saratoga Springs; that
is, the effluent is discharged into the aerating cham-
ber through an upright pipe, and overflows it just
as I have described in this case.

XQ. 115. I meant my last question to refer to
plants constructed by your own company; will you
189 please answer the question with that understand-
ing? A. As I think I before stated, in designing
plants, we are governed by local conditions. At
Glencoe, for instance, the septic tank is on the top
of a bluff, probably 75 feet above the beach of Lake
Michigan; the contact beds are located down on
the beach; the method of aeration there was de-

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signed to carry the tank effluent down the slope
of a bluff in steps, and at each step the effluent is
discharged into the upper part of a vertical pipe
6 or 8 feet deep, discharging at the bottom, and
so on, down to the foot of the bluff. The top of
each of these vertical shafts, I might call them,
being covered by an open iron grating. As I say 191
we are governed altogether by local conditions.

XQ. 116. So that the particular means adopted
by you for aeration may vary with each plant you
instal; is that so? A. Yes, sir; so long as bearing
in mind the object in view, that is, the exposure of
the tank effluent to the action of air and light, as
far as practicable. 192

XQ. 117. You were unable to remember the
details of arrangement of the small plant installed
near Trinidad, Colorado, but is there any small
plant constructed by your company the details of
which you can remember? A. The plant I have
described at Glencoe is considered a small plant,
being for about 1200 people. 193

XQ. 118. Do you remember the details of any
plant constructed by your company which is of
size substantially that of the one referred to as
having been constructed near Trinidad? A. No,
that is by far the smallest plant we have had any-
thing to do with.

XQ. 119. Can you remember where the next 194
larger plant to that of Trinidad was constructed?
A. I think at Cambridge, Illinois, designed to take
care of a population of from 75 to 100. In this
case subsequent treatment by contact is not resort-
ed to ,the effluent from the septic tank being dis-
charged through a long outfall drain to a creek, in

which it is supposed to sufficiently purify itself in the open stream to be void of nuisance.

XQ. 120. In this case, is there any areation of the effluent? A. No, it is supposed to get its areation in its passage down the stream, and being a small plant I think there will be no trouble on
196 account of lack of other aeration.

XQ. 121. Is this outfall drain a closed pipe running from the septic tank to the creek? A. Yes, that it is a covered pipe open at both ends.

XQ. 122. In connection with this plant, how does the effluent pass from the septic tank into the outfall drain? A. From the tank it passes through
197 a slotted pipe, extending across the outlet end, and is conveyed thence into an effluent chamber, and the outfall drain I have referred to leacs off from that chamber to the outlet.

XQ. 123. Is this plant provided with a settling chamber? A. Yes.

XQ. 124. And how does the sewage pass from
198 the settling chamber into the septic tank? A. Through inlets leading from this settling chamber down through the end wall of the tank, discharging into it at mid depth, very similar to that described at Moline.

XQ. 125. About what would be the dimensions of a septic tank of a plant the size of the one at
199 Cambridge, Illinios? A. The dimensions of the Cambridge plant would be about 16 or 18 feet long and about 5 feet wide; this statement is based on figuring and not from recollection; and it should be remembered that the dimensions of a tank are not governed entirely by the volume of flow, the character of the sewage has to be considered, and I do

not remember exactly upon just what basis the
Cambridge plant was designed.

XQ. 126. In your answer to XQ. 124 you state
that the sewage passes from the settling chamber
through inlets into the septic tank; for a tank of
the size mentioned, about how inlets would be pro-
vided? A. I think at Cambridge we allowed for 201
two inlets into the one tank.

XQ. 127. I suppose the number of inlet openings
would be increased according to the size of the tank;
is that so? A. Yes; the object being to distribute
the flow across the tank as completely as possible
to avoid agitation.

XQ. 128. Is there any special relation which 202
you aim to follow in the constructon of these tanks,
between the area of the inlet opening or openings
and that of the outlet opening? A. Both inlet and
outlet openings are designed large enough to take
any flow of sewage which may be anticipated. No
particular relationship between the two is aimed
at other than that they shall both be capable of 203
taking care of the maximum flow, without creating
any disturbance in the tank.

XQ. 129. If my recollection serves me right, you
have stated that for the purposes of the patent in
suit it is immaterial whether the outlet pipe from
the septic tank is one which has a slot extending
throughout its length, or whether a series of open- 204
ings are used to carry off the effluent. Is this cor-
rect? A. Yes; where the openings are sufficiently
numerous and close together, and extending sub-
stantially the entire width of the tank to perform
the same functions as a slot; or, in other words, its
mechanical equivalent.

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XQ. 130. What are the functions of the slot? A. . To allow the effluent to leave the tank at mid depth without undue agitation of the contents of the tank.

XQ. 131. So that you do not consider the number of openings, or the particular arrangement
206 thereof, material, so long as they carry away the effluent in the proper quantity with relation to the inflow, without agitation of the body of fluid in the tank? Is that correct? A. No, it is not material, so long as the result accomplished is substantially the same as would be accomplished by using a slot.

207 XQ. 132. All that is necessary, then, is for the outlet opening to be large enough to take care of the inflow and conduct it away, without agitation of the mass in the tank; is that correct? A. Yes, provided it is not only large enough, but arranged so that the discharge of the effluent extends substantially across the width of the tank.

208 XQ. 133. If the outlet opening is so arranged with respect to the fluid level, is of such size as to take care of the inflow and conducts the effluent away without agitation of the mass as would interfere with the septic action please give your reasons for your statement in the last answer that the opening must be arranged so that the discharge of the
209 effluent extends substantially across the width of the tank.

Objected to as indefinite, since it does not appear what is meant by the expression "take care of the inflow." It being obvious that a single round hole might be of such size as to take care of the inflow and possibly as not to produce agitation, in one sense but not in another.

A. The question is not clear to me.

XQ. 134. You have testified, have you not, that the outlet opening must be arranged at mid depth; 211
that is as I understand it, below the fluid level; is that so? A. Yes, it is.

XQ. 135. You have also testified that it must be of size sufficient to carry off the inflow without agitation of the mass in the septic tank as would interfere with the spetic action; that is correct, is it not? A. It is. 212

XQ. 136. These two statements being so, please explain why it is that the outlet opening must be "not only large enough, but arranged so that the discharge of the effluent extends substantially across the width of the tank." The quotation is from the answer to XQ. 132. A. Because it is not only desirable but necessary for the proper operation 213
of the septic tank that the outflow shall extend substantially across the width of the tank.

XQ. 137. Why is it desirable and why is it necessary?

Complainant's counsel understands the present line of cross-questions to be directed solely to the ascertainment of 214
the mechanical equivalent of the "slot" referred to in certain of the claims in issue.

A. Unless the slot or its mechanical equivalent extends substantially across the tank, it would not be possible to get an equable flow throughout the

215

width of the tank, which, as I have already stated,
is necessary for its proper operation. Suppose, for
instance, the outlet consisted of one or two holes
in the center or on either side of the outlet end of
the tank, the outflow would necessarily be at that
point, and would have a tendency to create a cur-
216 rent towards it, and the other portions of that end
of the tank would be deprived of an outlet.

XQ. 138. If I understand your last answer cor-
rectly, assuming a septic tank 16 feet long by 5 feet
wide and 5 feet deep, all the other features, such
as exclusion of air and proper arrangement of in-
flow being present, such an apparatus would not
217 be operative or practical if you should arrange the
outlet openings one on either side of the outlet end
of the tank; is that correct?

Objected to as a misinterpretation of the
testimony of the witness, he not having
said "necessary for the operation," but
having said "necessary for the proper
218 operation," and it not ap-
pearing to what degree the proper
operation of the tank would be impaired
by the alterations suggested in the ques-
tion, or that the witness has made the
necessary experiment to be competent
219 to say in the language of the question
that "such an operation would not be
operative or practical," or the contrary,
without qualification.

A. Under the conditions stated, that is, the loca-
tion of an outlet on either side of the outlet side
of the tank, the tank would probably operate, but

how successfully I am unable to say, never having tried the experiment.

XQ. 139. You have never experimented, then, to ascertain just to what distance along the end of the tank the slotted pipe should extend in order to accomplish the best practical results? A. I have
never found it necessary to, believing that better 221
results are accomplished by following as closely as possible the language of the patent in suit.

XQ. 140. Have all the plants which your company has constructed, so far as your knowledge extends, been provided with the outlet slot extending substantially across the greater part of the
width of the tank? A. Yes, either a slotted pipe 222
or its equivalent.

XQ. 141. Please state what you mean by "its equivalent"; that is, what equivalent you may have used? A. I have designed plants, small plants particularly, with a baffle board or slab extending from above the water level in the
tank to a depth of say two feet from the surface; 223
and another slab extending out from the outlet end of the tank to within an inch or so of the other; thus leaving an opening between the two for the effluent to pass through. This I consider one of the many mechanical equivalents which could be mentioned. In other words, it would accomplish
the same purpose in substantially the same way. 224

XQ. 142. In connection with the construction you have just described, where have you located the outlet pipe or opening from the tank? A. From the channel thus formed behind the baffle board.

XQ. 143. In such an event, then, you have one

outlet pipe from the tank, is that so? A. That is hardly so, because in that case the channel I have described is really effluent chamber and not the tank. The outlet from the tank in that case would extend the length of the opening between the baffle board and such other projection
226 in the end of the tank we may introduce.

XQ. 144. In such a construction is there any opening through the wall of the tank to carry off the effluent?

> Objected to, as it does not now appear what is to be considered the wall of the tank. Whether the baffle board
> 227 which separates the tank from what the witness has referred to as the effluent chamber, or the wall outside of said effluent chamber,

XQ. 145. By the wall of the tank I mean the wall outside of that which the witness has just
228 referred to as an effluent chamber. With that understanding, please answer the last question. A. There is an opening by which the effluent leaves the chamber I have called the effluent chamber.

XQ. 146. What is the shape of this opening to which you have just referred? A. It is round, although not necessarily so.

229 XQ. 147. What is the size of this outer opening? A. The size of this opening would depend entirely upon the volume of sewage to be taken care of.

Adjourned to Thursday, February 9th, 1905, 10.30 a. m.

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New York, February 9th, 1905, 10.30 a. m.

Met pursuant to adjournment.

Present, counsel as before.

Cross-Examination of Mr. Wyllie Continued.

XQ. 148. You have mentioned in your answer to XQ. 141 a baffle board or slab arrangement 231
which you have used as a substitute for the slotted pipe. Can you mention any other so-called "equivalents" of the slotted pipe which you have used? A. No, I have used no other equivalent.

XQ. 149. In your answers to XQ. 145, and 146, you have spoken of the round opening through which the effluent leaves the chamber. Please 232
state whether a pipe is inserted in this opening to lead off the effluent? A. My impression is that a pipe was used, or rather designed, to lead off the effluent from the effluent chamber. It would be the most convenient method of construction, I think, but it would depend altogether on conditions. 233

XQ. 150. In the specification of the patent in suit, on page 3, lines 112 to 117, it is stated:

"After treatment in the tanks A it (sewage or other liquid) passes through the slotted pipe or conduit 10 and pipes 17 into a conduit 20, whence it may be conducted to an aerator as in the previous arrangement, or direct to a filter or filters, if desired." 234

If it were conducted directly to a filter you would consider it essential, would you not, that there should be aeration at the filter, if not by some special form of aerator; is that so? A. Essential for what?

XQ. 151. Essential for the proper treatment

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of the effluent. A. Proper treatment of the effluent is a matter of degree and to what degree it is properly treated would depend the efficiency of the system adopted. Personally, I believe that to get the best results from this system the effluent from the second tank should be subjected
236 to as complete an aeration as is possible. In the case cited you do not state whether the filter is to be intermittent or continuous. If intermittent, it would receive a greater degree of aeration than if continuous; just what aeration would exist in a continuous filter would depend on the method of its distribution and the material used.

237 I consider that aeration is an important feature in the purification of the tank effluent.

XQ. 152. As I understand the matter, you consider the aeration of the effluent essential in the proper treatment of the sewage, and in all the plants of which you have spoken some way has been provided for aeration, either between the
238 septic tank and the filter bed, or in the filter bed, or perhaps in other ways; is that correct? A. It is substantially correct. Where complete purification of the sewage is desired this is undoubtedly true.

XQ. 153. But the point at which the aeration takes place is one that is determined by local con-
239 ditions, is it not? A. I think that would be true.

XQ. 154. In your answer to Q. 13 you have stated that in the examination of the Saratoga plant by means of a glass tube or gauge you were able to remove and examine samples of the sludge, the liquid, the scum, the effluent from

the septic tank and the effluent from the filter beds. What sort of an examination did you make; was it a mere occular examination, or did you have analyses made? A. My examination of the sludge, scum and the effluent from the filter were occular; that of the effluent from the tank
taken at this time was also occular; but a sample 241
of the tank effluent, which was taken at the aerator, was analyzed.

XQ. 155. What is the purpose of the aeration of the liquified sewage as it leaves the septic pool? A. For the purpose of introducing conditions favorable to the life and action of aerobic
bacteria, by which the process of purification 242
commenced by the aerobic bacteria is completed.

XQ. 156. Will you kindly point out on the plan drawing of "Complainant's Exhibit Engineering Article on Saratoga Plant," and also on the "Complainant's Exhibit Blue Print Saratoga Plant," the settling tank which forms an element
of claim 6 in the patent in suit? A. On the 243
"Blue Print Saratoga Plant" the chamber referred to is marked 14. On the cut in the Engineering Article referred to it is the chamber at the end of the force main, also marked 14 in red pencil.

XQ. 157. How do you know that the chamber
to which you have just referred is a settling tank? 244
A. It may not have been designed for that purpose, but should the sewage on reaching that point contain any coarse mineral matter, such as sand or gravel, it would inevitably settle. This settling arrangement is also provided for in the

245

defendants' plant at the pumping station, described in the Engineering Article referred to.

XQ. 158. Will you point out in the two exhibits referred to the outlet for the effluent from the septic tank? A. In the Engineering Article referred to the two horizontal rows of holes form-
246 ing the outlet from the defendants' plant are shown in the end wall on the cut "Interior View of Septic Tank, Looking Toward Outlet End," on page 83. On the Blue Print exhibit referred to, these holes 10a are shown on Fig. 4, "Section Showing Outlet End of Tank."

XQ. 159. Does this outlet to which you have
247 just referred comprise a conduit having a longitudinal slot open across the greater part of the width of the tank? A. No; these holes could hardly be described as a "conduit," but they open on to the floor of a conduit 10 shown on the Blue Print exhibit, Fig. 1, "Sectional Plan View," which I have already described. This
248 conduit extends substantially the entire width of the tank, as also do the holes leading into it.

XQ. 160. Does this outlet consist of a pipe extending across the greater part of the width of the tank, and having a longitudinal slot, or an opening in its wall throughout its length? A. No. the outlet described is manifestly not a pipe;
249 it is, however, a conduit, the alternative of the pipe, referred to in the language of the patent in suit.

XQ. 161. Claim 20 of the patent in suit, as to one of its elements, calls for "a non-disturbing inlet * * * provided with a broadened mouth." Please point out this element in the

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Cameron patent in suit? A. It exists in the language of the claim referred to, and in plants we have constructed under this patent we often use an inlet having a mouth of greater dimensions than the body of the inlet.

XQ. 162. Do you find any basis in the drawings or descriptive portion of the specification of 251
the Cameron patent in suit for such element? A. I find no special reference to a broadened mouth referred to in the specification, unless the language of the specification which I quote from line 59, page 1, "while permitting a non-disturbing inflow of the sewage into the pool," might be construed as suggesting such a device. It cer- 252
tainly does suggest the desirability of some such an arrangement. Referring to the drawings, it is not clearly shown, but might be inferred from the inlet shown on Fig. 2.

XQ. 163. Referring to Fig. 2 of the Cameron patent which you have just mentioned, what is the dotted line shown just within the left-hand 253
wall of the tank?

> This line of questioning is objected to on the ground that the interpretation as to what is the signification of the expression "broadened mouth," is a matter for the court.

> Counsel for defendants states in reply to 254
> the objection that witness has alleged infringement of claim 20 of the patent in suit, which claim mentions as an element the "broadened mouth." It is perfectly proper therefore for witness to be called upon to show by reference

255 to the specifications and drawings of the patent in suit the basis for the element mentioned.

In view of the above explanation by defendants' counsel of his question, the question is objected to as entirely im-
256 material to the interpretation of the words "broadened mouth" of the claim because the question, as now explained, is limited to only one of the openings 63 of the drawing, whereas the drawing shows in fact that the total mouth consists of more than one
257 such opening, and the same is true of the inlet mouth of the defendants' apparatus.

A. It is possible that the dotted line referred to is intended to indicate the inner wall of the inlet referred to, and probably does.

XQ. 164. With reference to the plants which
258 you have constructed, do you know of any in which the entire mass of solid organic matter in the septic tank has become liquefied? A. From a theoretical standpoint, possibly not. But from a practical standpoint, I should say yes. In the effluent from a septic tank designed with due regard to the volume and character of the sewage,
259 what organic matter remains in suspension is so comminuted as to present no obstacle to any subsequent treatment to which it may be subjected; that is, in contact beds or filters.

XQ. 165. So far as your experience has gone in the analyses of effluents from your septic tanks as constructed, is the entire mass of solid organic matter liquefied in the tank? A. With the qualifications mentioned in my last answer, yes.

XQ. 166. You consider, then, that under the scope of claim 1 of the patent in suit, it is not necessary that the whole mass of solid organic matter should be liquefied; is that so?

> Objected to as indefinite, because the 261
> question does not state whether the word "whole" in the question is used in a theoretical sense or a practical sense.

A. This is something that I have not considered. The scope of any of the claims of the patent 262
in suit involves questions that could probably only be decided by the court.

XQ. 166. You considered the scope of the claims of the patent, or certain of them, sufficiently to testify that the defendants' Saratoga Plant infringed those claims, did you not?

> Objected to since the question of in- 263
> fringement is for the Court to determine, and it is thought that the witness has not used the word "infringement" anywhere in his deposition thus far; his statements having been that the Saratoga Plant and its operation are described by and con- 264
> form to the language of certain of the claims of the patent in suit.

A. I was not aware that I had testified that the defendants' Saratoga Plant infringed the claims mentioned.

XQ. 168. You did testify, however, did you

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not, that you found in the Saratoga Plant the elements set forth in claims 1 to 8, inclusive, 11, 12, 20, 21 and 22, of the patent in suit?

> Objected to since the witness's answers to Q. 24, and at the end of answer to Q. 22, show precisely what the wit-
> 266 ness has stated on this point.

A. In my answer to Q. 22 I quoted from the specification, commencing with line 81, page 1, referring to the treatment of the sewage, and added that the process described is exclusively bacteriological and that it is accurately and literally described in certain of the claims of the
267 patent in suit. And in my answer to Q. 24 I testified that the language of each of said claim describes literally the process carried on in the defendants' plant. These statements I now reiterate in answer to the question.

Recess.

268 New York, February 10th, 1905, 10.30.

Met pursuant to adjournment.

Present, counsel as before.

The Witness Wyllie states: That in compliance with XQ. 95 he has telegraphed to Chicago for the plans of the small Cameron plant near
269 Trinidad, and having just received a blue print of the same, now hands it to counsel for defendant for use in the case if he desires. He further states that on this blue print the location of the plant is given as New Mexico, and he understands that Trinidad is in Colorado, and the ranch is in New Mexico.

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Counsel for defendants introduces the said blue print in evidence and it is marked "Defendants' Exhibit Cameron Trinidad Plant."

XQ. 169. Referring to the exhibit which has
just been introduced, will you please describe the 271
blue print in detail, putting suitable letters upon
the same? A. I do so as follows: The main
sewer 13, discharges into the settling tank 14,
from which it passes through inlet 63 into tank
A. On its entrance into the tank at the inlet end
it moves slowly and bodily forward towards the
outlet end of the tank A., leaving the tank
through the outlet 10, which extends and is open 272
throughout the entire width of the tank. Both
the inlet 63 and the outlet 10 are disposed at mid-
depth. After passing through the outlet 10, the
sewage enters an effluent chamber 10b, and is
conducted therefrom in the effluent carrier 17 to
the aerator 18, from which it is distributed alter-
nately over the surface of the two contact beds 273
69 in open channels.

XQ. 170. What is the construction of the
aerator marked 18? A. The construction and
operation of the aerator marked 18 is as follows:
The tank effluent as it leaves the effluent carrier
17, is discharged on to an inclined plane over
which it flows in thin films into the aerating and 274
distributing chamber below, from which it is dis-
tributed over the surfaces of the two filters 69 al-
ternately, through the open channels marked 100.

XQ. 171. What are the dimensions of the incline plane over which the liquid flows? A. It scales a trifle less than a foot long and about six or eight inches wide. In addition to the aeration received by the tank effluent in flowing over this surface, the aeration is continued, of course, in its distribution through the open channels and on the surfaces of the contact beds.

Cross-examination closed.

276 Re-Direct Examination by Mr. Gifford.

R-d-Q. 172. In your cross-examination as to the plants constructed in accordance with the Cameron system described in the patent here in suit, you have omitted mention of any in England, I believe. And I notice that in your letter of April 3rd, 1902, herein, you made mention of
277 185 plants installed in Great Britain within the previous three or four years. Please state how large any of those plants were; that is to say, how large the population it took care of. A. The plants referred to as having been constructed in Great Britain vary in size from small plants for individual country residences and institutions, to
278 cities of about 50,000, and I believe over. One plant that I have seen in operation at Exeter takes care of a population of about 50,000; another at Barrhead, North Britain, which I have visited and inspected, takes care of a population of 10,000. Cromer, another city where the Cameron system has been installed, has a population
279 of, I think, 60,000.

R-d-Q. 173. You have stated that in designing plants under this Cameron system you were governed by local conditions. What part of the plant do local conditions govern, what part not? A. When I stated we were governed by local conditions I should, perhaps, have added "so far as

the subsequent treatment of the sewage is concerned after leaving the septic tank." In all plants, large and small, the method of treatment in the septic tank is the same, as well as the design of the septic tank itself. The sewage enters the tank at mid depth at one end and flows
bodily and slowly toward the outlet end, where 281
it is discharged through an outlet, also at mid depth, extending across the greater part of the width of the tank. The object of this is to give the solid matter in the flowing sewage an opportunity to rise to the surface or fall to the bottom, according to its specific gravity, thus forming in
a flowing pool the scum and the sludge for the 282
development of the anaerobic bacteria by which the liquefication of the solid organic matter of the sewage is accomplished.

R-d-Q. 174. In other words, as I understand you, under all conditions in designing the plants under the Cameron system you have, so far as
the septic tank is concerned, invariably followed 283
substantially the form and general proportions of the long, shallow tank, shown in Figures 1 and 2 of the drawings of the patent in suit and containing provision for the maintaining there through of an equably and bodily flowing current of the liquid from inlet to outlet between the overhead
scum and underneath sludge? A. We have and 284
do.

R-d-Q. 175. Is it your understanding that the plant represented by "Defendants' Exhibit Cameron Trinidad Plant" (which I believe you have said was the smallest built in this country under the Cameron system) served to dispose of the sewage from only a single house, or from a collection of houses or buildings? A. As I have before stated, I have never seen this plant; but as I remember it, it takes care of the sewage from the ranch house, and other buildings, such as servants' quarters, and possibly the stable.

286 R-d-Q. 176. Please designate on "Defendants' Exhibit Cameron Trinidad Plant," by the number 101, the outfall pipe from which the finally purified sewage is discharged from the filter bed. A. I have done so.

R-d-Q. 177. Considering the mouth of the inlet into the septic tank as consisting of both the
287 openings 63, 63, in what way, if at all, is that mouth shown as broadened in Fig. 1 of the drawing of the patent in suit? A. In the sense that it extends from one opening to the other.

R-d-Q. 178. In other words, as I understand you, the total mouth is broadened by spreading the parts of it, 63 and 63, apart across the end
288 of the tank.

Objected to as leading.

A. Yes, sir; and this is for the purpose of distributing the flow across the tank and for the maintenance of a more equable flow of fluid.

R-d-Q. 179. How does this means of broadening the mouth of the inlet of the patent in suit
289 compare with the means by which the defendants broaden the mouth of the inlet to their septic tank, as shown on "Complainant's Exhibit Blue Print Saratoga Plant?" A. They adopt exactly the same method of distribution, discharging the sewage into the tank at four points about equidistant across the width of the whole tank, there-

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by accomplishing the same results as is accomplished in the Cameron patent in suit.

R-d-Q. 180. In your examination of the operation of the defendants' plant at Saratoga Springs, at which end of the tank did you find the scum to be the thickest? A. At the outlet end. At the inlet end it was less than a foot thick; at the 291
outlet end it was about three feet.

R-d-Q. 181. And was its increase in thickness gradual from the inlet toward the outlet end? A. That I am unable to say; I only examined it at two points; one at the inlet end and one at the outlet end. I am referring to my examination on November 21st, 1904. 292

Complainant rests prima facie case, and expresses the desire that the defendants expedite the introduction of their case as much as practicable.

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UNITED STATES CIRCUIT COURT—NORTHERN DISTRICT OF NEW YORK.

CAMERON SEPTIC TANK COMPANY,
Complainant,
against
296 VILLAGE OF SARATOGA SPRINGS, AND THE SEWER, WATER AND STREET COMMISSION OF SARATOGA SPRINGS.
Defendants.

In Equity No. 7025.

Reply testimony on behalf of the defendants for
297 final hearing, taken at the office of Gifford & Bull, 141 Broadway, New York City, before C. E. Davidson, Notary Public.

New York, June 8, 1905, 10:30 A. M.

Met pursuant to notice. Present: C. L. Sturtevant, Esq., J. J. Healey, Jr., Esq., and S. W. Ban-
298 ning, Esq., Counsel for defendant. Livingston Gifford, Esq., Counsel for Complainant.

F. Herbert Snow, a witness produced on behalf of the defendants, being first duly sworn, testifies as follows:

Q. 1. Please state your name, age, residence and
299 occupation? A. My name is F. Herbert Snow. I am 39 years old. My home is Brockton, Massachusetts, and I temporarily reside in Boston. I am a civil, sanitary and consulting engineer; member of the American Society of Civil Engineers, doing business under the firm name of Snow & Barbour, with offices at Boston, Mass., and Columbus, Ohio.

F. HERBERT SNOW. 300

Q. 2. Please state what education and experience
you have had which enables you to qualify as an
expert in this case? A. In the Spring of 1882 I
graduated from the Mansfield High School and took
up the study of surveying and engineering in the
office of Thomas Keith of Brockton. In this office
I did considerable work for Mr. Amasa Glover, an 301
inventor of sewage disposal apparatus, and through
his representations I began a special study of sani-
tary engineering. Subsequently I was employed
by different engineers and in January 1890 was
elected City Engineer of Brockton.

I designed and built the sewage disposal works
and the sewerage system there, also the surface 302
drainage system. I was engineer until 1898 and
then sewerage commissioner until the middle of
1900, when I resigned on account of inability to at-
tend to the duties of that office and my profession-
al calls out of the State.

In connection with the Brockton disposal works,
I constructed and equipped a chemical laboratory 303
and there had exceptional opportunities to study
on a practical scale, sewage purification as accom-
plished in that city. This laboratory was the first
one built in this country in connection with the
operation of sand filters on a large scale.

I have been associated with sanitary improve-
ments in over 30 municipalities in this country. 304
The work accomplished by my partner and myself
in connection with sewage disposal plants has been
original, novel, and to-day is quoted by other en-
gineers as typical of the best American practice.

Among my consulting work I might mention that
to the Ohio State Board of Health, by appointment

305 of the Sanitary Committee of the North West Territory Exposition, that to the sewer department of the City of Boston, and that to the engineer of the Massachusetts Metropolitan Water and Sewerage Commission.

Besides being a member of the American Society
306 of Civil Engineers, among other societies I might mention, the Boston Society of Civil Engineers, the Engineers Club of Columbus, Ohio, the National Public Health Association, the Association of Boards of Health of Massachusetts, etc.

As types of the sewage disposal plants with which I have been connected, I will mention the one at
307 Brockton, the one at Saratoga Springs and the plant at Mansfield, Ohio. In these plants either directly or in conjunction with my partner or under our joint supervision, the plans were designed and the works constructed and, with the exception of the Mansfield plant, operated.

Q. 3. Have you examined and do you under-
308 stand the construction and mode of operation of the sewage system and apparatus set forth in the patent in suit? A. I have and do.

Q. 4. Have you examined and are you thoroughly familiar with the Saratoga Sewage Disposal Plant? A. Yes. This plant was designed in the office of Snow & Barbour, and constructed by us
309 under the more personal supervision of my partner, Mr. Barbour, and after its construction it was placed in our hands for management during the first year of its operation. I am familiar with all the details of the design and the construction of this plant and equally share in the responsibility for the design and construction of the same.

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Q. 5. Does the blue print exhibit of the Saratoga plant, introduced and marked "Complainant's Exhibit Blue Print, Saratoga Plant," substantially illustrate the Saratoga plant? A. It does substantially, but there are some elements of the plant not fully or properly shown in said exhibit.

Q. 6. Can you produce copies of plans of the Saratoga Plant, from which the same was constructed? A. Yes. 311

Witness produces set of plans, and they are offered in evidence and marked "Defendants' Exhibit, Plans of Saratoga Sewage Disposal Plant," the sheets of tracings being respectively numbered 312
from 1 to 8, inclusive.

Q. 7. Please explain these plans, referring to the separate sheets by number, and if you consider it necessary, using blue pencil lettering to indicate the various parts? A. These sheets fully and truly show the features of the Saratoga plant imperfectly represented in exhibit of the same. Sheet 313
1 shows the details of the filter beds and the arrangement of the septic tanks, sludge beds, the aerator and dosing tank and the sand filters, the sheet being a plan of the entire disposal plant.

Sheet # 2 is a plan and section of the septic tank, showing the general arrangement of the tanks, the various in lets and outlets and the form of con- 314
struction.

Sheet # 3 is an elevation through the tank, showing the general arrangement of the inlet and outlet therefrom and the method provided and the means thereof of removing the sludge from the tank to adjoining sludge beds for drying out purposes.

315 F. HERBERT SNOW.

Sheet # 4 is a plan and elevation in detail of the inlet end of the septic tank for one of its compartments.

Sheet # 5 is a plan and elevation of the details of the outlet end of the septic tank for one of its compartments.

316 Sheet # 6 is a plan and elevation of the aerator and dosing tank and sheet # 7 is a plan and elevation, showing details of the gates, chambers and surface distributing troughs for conveying the sewage from the dosing tank to the surface of the sewage filters.

Sheet # 8 shows detailed plans and elevations
317 of the under drainage system and means of aerating the filter beds.

Q. 8. Referring to these plans, please describe in detail, the construction and mode of operation of the system therein disclosed and I would suggest that you use reference letters or numerals to indicate the various parts? A. The septic tanks
318 or tank is divided into four units, each 91½ feet long, by 51½ feet wide, and separated from the adjoining tank by a division wall, as shown in sheet # 2. The tanks are covered by an arched roof, supported on piers and the walls, and over this roof is an 18 inch covering of earth. The entire structure is built of cement concrete, and is water
319 tight.

The sewage enters the septic tanks at the end of the sewer at a point marked "A" on sheet # 2, from which a vitrified pipe, marked A, is carried across the inner end of the tank, connecting with an inlet chamber at the center of each one of the four compartments, or tanks, said inlet chambers being

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marked respectively on sheet # 2, B, B1, B2 and B3. These inlet chambers are provided with gates permitting the shutting off of any tank as desired. From these inlet chambers a vitrified pipe extends to inside of each tank, the said pipe inlet dividing at the center and extending both ways across the end of the tank. 321

The depth of the sewage at the inlet end of each tank is 7¾ feet. The said inlet pipes admit the sewage to the tanks at an elevation 3½ feet below the high water line in each tank and there are four openings in the inner pipe in each tank as shown on sheet # 2, and more fully exhibited on sheet
\# 4, being marked C, C1, C2 and C3. The arrange- 322
ment for the entrance of the sewage from the end of the sewer or force main into the tanks, and the arrangement of the vitrified pipe extending therefrom to the inlet chamber, the inlet chamber, gate and the inlet pipe into the tank therefrom, are shown in complete detail on sheet 4, the various parts being lettered, as previously stated. 323

The sewage is discharged at the opposite end of each tank from the inlet end through 96 two inch pipes, arranged in horizontal rows, 3½ feet below the water line, the depth of the sewage at this end of each tank being 8¼ feet, whence it flows into a narrow chamber extending the width of each tank,
which chamber is marked D, on sheet # 2, and from 324
which it flows over a weir, located in a weir chamber, of which there are two, each weir chamber being located between the first and second tank and between the third and fourth tank, as shown on sheet 2, the weirs being lettered respectively E and E1. From the weir chamber, the sewage flows into

an outlet chamber lettered F on sheet # 2. On
sheet # 5, a plan and elevation are shown, giving in
detail the dimensions and arrangements of the two
inch outlet pipes lettered F and the collecting
chamber D and the weir E and the outlet chamber
F. The elevation of the weir is such that it seals
326 the inlets and outlets into the tanks, the said inlets
and outlets thus forming traps hermetically sealing
the tanks.

Provision for emptying the tanks of accumulated
solids is made by means of sloping the bottom of the
tanks towards the outlet ends thereof, whence, from
a depression in the bottom of each tank, a large
327 pipe, 24 inches in diameter, is arranged to convey
the said solids, termed sludge, onto sludge beds,
located directly in front of the tank and provided
specificially for drying out the said sludge and disposing of it, there being two of these sludge beds,
each being arranged to receive the sludge of two of
the tanks.

328 The 24 inch sludge pipes, are shown on sheet # 2,
and lettered G. The details of this mode of disposing of the sludge is shown on sheet # 3.

A 12 inch gate and pipe marked H, on sheets # 2,
3 and # 5, located at a higher elevation than the
sludge outlet pipe, make it possible to draw off the
clear liquid from each tank between the scum and
329 the bottom and apply it to any filter, previous to the
removal of the sludge.

From the outlet chamber the sewage flows to an
aerator, distant about 150 fet from the said outlet
chamber and connected therewith by a 16 inch iron
pipe. This aerator is made of sheet iron plates
placed in three layers in umbrella form, around a

 330

central rising pipe. The sewage rises through this central pipe and flows over the said plates in a thin sheet, and thence the sewage goes to the adjoining dosing tank. The aerator may be cut out of operation if desired, the sewage flowing directly from the outlet chamber of the tanks to the said dosing tank.

Recess until 2 o'clock. 331

The sewage from this dosing tank is automatically delivered to the filter beds by a siphon, actuated by a float, both being located within the dosing tank. A detail plan and elevation of the aerator, dosing tank, etc., is shown on sheet No. 6, the aerator being lettered i and the dosing
tank j. 332

The sewage from the dosing tank is distributed onto the filter beds, which comprise 18 beds each an acre in size, through pipes generally 24 inches in diameter laid in the embankments dividing the filters, said pipes being above the surface of the filters and connecting with the filters
by means of gate chambers located in the em- 333
bankments between the beds and opposite their centers. The outlets from these chambers are 15 inch pipes extending on either side through the embankment to the beds and protected at their outer ends by concrete abutments. From each of these abutments a carrier, for the purpose of dis-
tributing the sewage uniformly over the surface 334
of each bed, extends 180 feet across the bed. The details of these gates, chambers, distributing pipes and carriers, are shown on sheet No. 7. They are similar to those used by me at the Brockton Disposal works designed in 1892.

The system of under drainage of the filter beds

335

in its general arrangement is shown on sheet No.
1. One line of under drainage only was laid in
each bed about 6½ feet deep and a main line of
10 to 15-inch drainage was placed at a depth of
about 11 feet, the smaller drainage being con-
nected with it. Manholes were placed at the
336 junction of the mains and smaller drainage, and
the upper ends of all drains were turned up and
carried to the surface in order to secure aeration
and reduce to a minimum the accumulation of
carbonic acid gas in the body of the filters. The
ventilation of the under drainage had been pre-
viously accomplished at the Brockton filter beds,
337 designed in 1892. The details of the under drain-
age system and appliances for promoting aera-
tion are shown on sheet No. 6.

Q. 9. Please compare the plans of the Saratoga
plant with the drawings of the patent in suit
and point out the mechanical differences between
the two systems? A. In the drawings of the
338 patent in suit, referring to figures 1, 2 and 3, the
sewage coming through the sewer is delivered
into a well where grit and other solid matters are
allowed to settle. This element is dispensed with
in the Saratoga plant. All matters contained in
the sewage being delivered from the sewer into
the Saratoga Tanks. In figure 1 of the patent in
339 suit there are two inlet pipes shown located
above the level of the sewage in the tank being
brought into the tank at this level and turned
down, discharging beneath the surface of the
water in the tank. In the Saratoga plant each
tank has one inlet pipe which is located about
three feet below the level of the water in the

tank, said pipe entering in the center of the tank and branching both ways with open ends and tee openings provided at 1-3rd distance from said end, making in all four openings out of said pipe inlet into the tank.

Figure No. 3 of the patent in suit shows a tank arched over resting upon the side walls and free from any pillar or other obstructions to the passage of the flowing sewage in said tank. In the Saratoga plant each compartment or tank is provided with many obstructions to the passage of the sewage through the tank, being the pillars used to support the roof over the tank. 341

In the patent in suit the sewage passes out of the tank through a pipe or conduit located in the tank at the opposite end from the inlet, said pipe being provided with slots or apertures, which the patent states may be placed in any position along the said pipe or conduits, so as to admit liquid into the same in a downward, upward, horizontal or oblique direction and if found desirable, the slots or apertures may be protected by a deflecting surface or surfaces, so placed as to ward off solids or liquids coming from any particular direction, and the slots and apertures may also be provided with a strainer for the exclusion of solid matter and the pipe or conduit may be fixed or movable. In the Saratoga plant there is no structure of this kind, or for this purpose, disposed within the tank. 342 343 344

There are ninety-six two-inch pipes laid in two horizontal rows in the wall at the outlet end of each tank opposite the inner tank at a level about half way between the top and bottom of said wall,

345

through which the sewage passes from the tank to a chamber outside of it. In the patent in suit, figures Nos. 1, 2, 5, 8, 9, 10 and 11, only two such pipes, 17, are shown in the wall at the outlet end of the tank, thereby concentrating the flow of the tank at two points, whereas in the Saratoga plant
346 the flow is not concentrated out of the tank, but is divided and passes out through 96 pipes.

In the patent in suit, figures 1 and 2, after the sewage has passed out of the tank through the two pipes, above described, the sewage enters a chamber extending the whole width of the tank, the wall of the tank comprising one wall of said
347 chamber and the other wall of said chamber comprising a weir for its entire width, said width being the entire width of the tank, over which the sewage flows. In the Saratoga plant the sewage also passes into a chamber extending the whole width of the tank, the wall of the tank comprising one wall of said chamber, but instead of the
348 other wall of said chamber comprising a weir the sewage is conducted lengthwise of said chamber where, at the end, there is a weir over which the sewage flows.

This weir, in both the patent in suit and defendants' plant, maintains the level of the sewage in the tank.

349 In the patent in suit, figures 1, 2 and 3, a slotted pipe is disposed in the bottom of the tank for the purpose of removing from the bottom of the tank mud or deposited material, and to aid in dislodging or breaking up such material other pipes are provided to be laid on or near the floor of the tank and connected with a water main or

 350

other source, so that a stream or streams of fluid may be impelled against such deposited material. In the Saratoga plant there is no such pipe disposed on the bottom of the tank and further no arrangements are provided to break up or dislodge deposited material by the force of a stream.
Such arrangements as in the patent in suit would 351
be totally inadequate for the purpose of removing the accumulated solids for whose removal the apparatus, provided for in the plant as constructed, was designed. It is expected that in defendants' plant these accumulated solids will be very considerable.

An essential element of the Saratoga tank is 352
adequate provision for the removal of large quantities of deposited solids from the tank to large sludge beds, so called, specially provided for and set apart for the reception of and the disposal of said sludge. I made a similar provision for the adequate removal of deposited solids in the settling tank at Brockton, Massachusetts. 353
There is nothing novel in this arrangement, however, as it has been used in sewage disposal works for 50 years or more. In this respect defendants' plant very materially differs from the patent in suit.

Another distinct element of the Saratoga plant
is the outlet pipe from each tank by which, when 354
it is desired to empty each tank of the deposited solids, the liquid above the solids may be drawn off from each tank. The drawing off of this liquid and its purification on the regular sewage filters is amply provided for as heretofore described.

Another distinct feature of defendants' plant is the outlet chamber.

In the patent in suit the aerator is shown located adjacent to the tank. In defendants' plant the aeration is obtained at the dosing tank, which is removed some distance from the tank,
356 after the sewage has passed over the weir at the tank and through the outlet pipe a distance of over 150 feet.

In the patent in suit, as previously described, in passing out of the tank the sewage enters into the first compartment of the aerator, passing out through an opening at the top into a slightly
357 sloping surface down which it flows in thin films until it falls into the next compartment. This operation being repeated until it arrives at the last compartment, whence it may, if desired, be conveyed through a pipe to a filter or filters. Instead of employing the form of aerator above described an overhanging lip, or lips, may be pro-
358 vided, over which the effluent falls in a thin film, or films, exposed on both sides to the air. In the Saratoga plant this form of aeration or this particular arrangement is not used. Aeration in the Saratoga plant is intentionally secured at several points in the process of purification. First over the weir chamber, second in the specially ar-
359 ranged aerator at the dosing tank, third, in the specially provided distributing carrier located on the surface of the beds, fourth in the body of the filter, fifth in the under drainage and sixth on its final discharge from the main under drain to the brook.

The patent in suit provides for aeration only at the weir outlet of the tank. The Saratoga plant provides for it here at the weir, and also at a secondary point, before the sewage is conducted through a pipe to the filter or filters.

Q. 10. When did the bacterial era in the art of sewage purification begin? A. The bacterial era
in the art of sewage purification dates from about 361
1882, when the agency of micro-organism in reducing organic matter in soil to mineral compounds first began to be generally recognized.

Q. 11. What generally was the condition of the art prior to this time? A. Frankland's experiments for the Rivers Pollution commission
of England paved the way for this era. They 362
were the first experiments of their kind. Their object was to determine the effect of downward filtration of sewage through various soils. They extended over the years 1868 and 1869 and showed the filter action to be two-fold, first mechanical and second chemical. That the action therein
was also bacterial, was not then known, but cer- 363
tain cardinal principles were announced which prevail today in the art. Principal among them was the fact that the first essential of filtration is *aeration,* and second, to this end the operation must be intermittent to cause air to follow the sewage in the filter.

This was a discovery. It proved vegetation to 364
be unessential to sewage purification.

It was shown that the new idea called "Intermittent Filtration" differed not from the much practiced "Land treatment" or sewage farming in these respects, that in both the suspended solids were first removed and the matters in solu-

365 tion was next purified by chemical action in the pores of the soil through absorption of atmospheric oxygen, yet intermittent filtration did more—it controlled, modified and intensified the natural land operation thereby permitting higher rates and requiring less area.

366 Adjourned until Friday, June 9, 1905, at 10.30 a. m.

New York, June 9, 1905, 10:30 A. M.

Met pursuant to adjournment.

Present: Counsel as before.

Direct examination of Mr. Snow continued:

Q. 12. Please define what is meant by "land
367 treatment" or "sewage farming" and "Intermittent filtration?" A. By land treatment, was meant the spreading of the sewage broadcast over natural ground for the purpose of fertilizing crops. By "Intermittent filtration," was meant the filtering of sewage down through soil, the soil being either in natural position or artificially placed, the
368 application of the sewage therto being intermittent and in such maximum quantity as the particular filtering material would purify. This purification was not dependent upon the agency of vegetation.

Q. 13. What was the first practical demonstration of the idea of "intermittent filtration"? A. The first practical demonstration of this new idea
369 was made by Mr. Bailey Denton at Merthyr, Tidvil, in 1870 and '71. It was vigorously combatted by numerous staunch adherents of sewage farming, who maintained that vegetation was essential to sewage purification.

Q. 14. How was filtration regarded in America at this time? A. In the fourth annual report of

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the Massachusetts State Board of Health for the year 1872, the possibilities of disposing of the sewage of the City of Worcester by "Intermittent filtration" were outlined.

Again in the Special Report of the Board, 1876, it was stated that details of the proposed disposal
of Worcester sewage should be determined by ex- 371
periments.

Up to this time, it should be remembered, the process of purifying sewage in a specially prepared filter was thought to be one of oxidation only. It was thought to be chemical in its character, and not bacterial. Such was the state of the art of purify-
ing sewage during the transitory period between 372
the beginning of the decline of old methods and the advent of the bacterial era.

Q. 15. How was the bacterial era ushered in? A. The bacterial era in sewage purification may be said to have been ushered in in 1877. For a long time previous, chemists generally knew that where
ammonia and nitrogen of organic bodies were 373
oxidied in the soil, nitric acid was produced. But the manner in which this oxidation occurred remained unknown until about 1873. Early in 1877 the French chemists, Schloesing and Muntz, published some preliminary experiments conducted at the Paris Sewage Farm, proving that the puri-
fication—the nitrification in the soil—is due to the 374
action of a living ferment existing in soils and impure waters.

Robert Warrington, an English chemist, pursued similar researches, and in 1882 published a paper entitled, "Some Practical Aspects of Recent Investigations on Nitrification," in which he declared that the purifying action of soil is due to, first, the simple separation of suspended matters; second, retention by soil of ammonia and organic substances in solution; and third, oxidation of both by the agency of living organisms.

The first he showed to be mechanical, the second
376 a chemical action, and the third, one depending on the first two and the biological condition.

Further, he showed that a (porous) medium, like sand, is not necessary, that nitrification (complete purification) may occur in a bottle, but soil and perosity are favorable to rapidity of the process. Aeration was shown to be an important func-
377 tion of speed of the process. It was also shown that sewage supplies the nourishment for the oxidizing bacteria, that these organisms are present in surface soils in proportion to the presence of organic matter, and that it is possible to construct artificial beds of greater oxidizing power than a natural soil.

It is important for one wishing to understand
378 the history of the art to fully grasp the force of Warrington's declarations. They shed a new and great light upon the whole sewage disposal problem.

It was partly with a view of calling the attention of English and American chemists to the importance of the matter, that Mr. Warrington was in-
379 duced to bring up the subject again in 1884. He then made public further important researches in which he complained that in spite of the fact that it could not be conceived how the evidence for the ferment theory of nitrification could be further strengthened, and although nearly the whole of this evidence has been before the scientific public,

for seven years, yet the ferment theory of nitrification could hardly be said to have obtained a general acceptance. It had not been seriously controverted, but it had neither been embraced.

In this last classical effort of Mr. Warrington was brought out, among other things, the point that
nitrification commenced first in the weakest sew- 381
age, proceeds more rapidly in Summer, and in a thin layer of sewage, owing to greater supply of oxygen. It was shown that a solution *seeded* with a small amount of the nitrifying organisms would take a long time to purify, but one receiving an abundant supply would be speedily purified. It
was shown that the speedy purification of sewage in 382
soil is owing to the great mass of nitrifying organisms contained therein, and to the thinness of the liquid layer which covers the sand particles.

Q. 16. Will you kindly give your authority for the statements made in the answer to the last question, with reference to the writings of Warrington?
A. I refer to Journal of the Society of Arts.. Pub- 383
lished for the Society by George Bell & Sons, 4, 5 and 6 York Street, Covent Garden, London, 1882, same being Vol. 30, from Nov. 18, 1881, to Nov. 10, 1882, Page 532.

Article entitled " Some Practical Aspects of Re-
cent Investigations on Nitrification by Robert War- 384
rington." Also, I refer to a publication, entitled:

" Report of the Fifty-fourth meeting of the British Association for the Advancement of Science, held at Montreal in August and September, 1884, London, John Murray, Albermarle Street, 1885."

The article referred to, beginning on page 682 and being entitled, "On nitrification, by R. Warrington."

Q. 17. Please give a history or summary of the state of the art as to sewage purification and disposal in England at the time of which you have just been speaking? A. In summing up the art at
386 this time in England it is well to bear in mind that during the previous quarter of a century, the field of investigation had been apparently exhausted. Earth, air, fire and water had all been resorted to, the resources of chemistry had been ransacked, and prevailing practices were unsatisfactory.

It was recognized that no chemical process per
387 se, could effeciently deal with sewage, but must be assisted by subsequent land treatment.

Where land could be reasonably acquired, irrigation was the most satisfactory known system of sewage disposal, but it was not a money making matter.

"Intermittent filtration," as expounded by
388 Frankland, was taken to mean no more than the production by deep drainage of results frequently obtained in irrigation.

Towns situated upon the seacoast, or within the tidal range of rivers were thus afforded by crude sewage disposal therein, the most economical and efficient means of dealing with their sewage, pro-
389 vided due care was exercised in selecting the best position for the outlet.

Turning to America, the early bacterial era witnessed in the 1882 report of the Massachusetts State Board of Health, the recommendation of a definite plan of disposal of Worcester sewage by "Intermittent filtration." Four years later the Legisla-

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ture conferred power upon the said Board to advise cities and towns, and in 1887, on application by the City of Brockton for advice as to the best practical method of disposal of that city's sewage, the Board recommended "Intermittent filtration." In 1886, the Massachusetts Drainage Commission
recommended the filtration of Mystic Valley sew- 391
age on the Saugus Marches, also for the upper Charles and Nefonset, and the Sudbury and Cochituate basins, twelve (12) independent intermittent filtration and irrigation systems. This scheme was not adopted, but about this time, "intermittent filtration" began to be practiced at various places
in Massachusetts and elsewhere. In this country, 392
it first took the form of intermittent doses upon cultivated land and also by sub-surfaced irrigation, a few inches under the surface, especially used in small plants; and finally upon beds of sand or gravel, etc., specially prepared for the purpose. All act upon the same principle of bacterial action and
all require intermittent dosing and aeration. 393

Q. 18. What was the next important step or phase of development? A. The next great and important move was made in 1887 in connection with the disposal of the sewage of London. Mr. W. J. Dibdin, chemist to the Metropolitan Board of Works, was called upon in 1884 to devise some
means of purifying the River Thames. Early in 394
his experiments he found that as soon as the dilute action of the river water was sufficient to nullify the antiseptic action of certain sterilizing agents, the putrefactive organisms introduced from the river multiplied enormously and the whole mass of sewage underwent putrescent fer-

mentation, bringing about the original foul condition, but where pernamgenate of soda was employed the *oxidation* of the sewage could be affected in the river without putrefaction because this chemical prevented the increase of the putrefactive organisms, whilst producing the con-
396 ditions necessary for the well being of those organisms through whose agency the organic matters were *oxidised.*

Thus stirilization of sewage was found to be a mistake and the principle of Warrington further enunciated that efforts should be made towards fostering the class of organisms by whose
397 aid purification is finally accomplished.

In Mr. Dibdin's paper, read before the Institute of Civil Engineers, in 1887, he said:

"The lesson to be learned from the numerous experiments published by various authorities, both in this Country and on the Continent, is that bacteria and other low forms of organic life are most potent in the destruction of all objectionable refuse. Modern experiments show that, when the
398 subject is better understood and thoroughly worked out, in all probability the true way of purifying sewage where suitable land is unavailable will be first to separate the sludge and then turn into the neutral effluent a charge of the proper organisms whatever that may be, specially cultivated for the purpose, retain it for a sufficient period, during which time it should be
399 fully aerated and finally discharge it into the stream in a really purified condition. This is indeed only what it aimed at and imperfectly accomplished on a sewage farm. It is true that knowledge on the subject is not yet sufficiently advanced to put such a system into practical operation, but sufficient is known to show that the antiseptic treatment of sewage is the reverse of nature's method."

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With his future possibility in mind he recommended, and the City of London adopted in 1887, the plan of treating the sewage by chemicals and turning the clarified effluent into the Thames, wherein oxidation and complete purification by bacterial action would be accomplished.

This was an important action. Mr. Dibdin's 401
views of filtration at this time were antagonistic.

In reference thereto in the same paper he said:

"As regards the question of sludge, it is generally admitted by practical sanitarians that filtration is out of the question. As affecting the future purification of a clarified sewage, filtration is without doubt a rational process in all respects save one,
and that is expense. If further purification is de- 402
sirable, and suitable land can be obtained, filtration in the form of effluent farming is to be commended beyond all other proposals. But land must be suitable and not over dosed with the liquid to be purified, otherwise ultimate failure is a foregone conclusion."

The adoption of the chemical precipitation pro-
cess by the English Metropolis in the face of re- 403
peated failures of the method throughout the Kingdom, coupled with Mr. Dibdin's adverse position towards filtration, put a quietus for the time being on progress in sewage filtration in England. So the time was ripe for the new world renowned classical researches of the Massachu-
setts State Board of Health. 404

Q. 19. Please state what these researches of the Massachusetts State Board of Health were and what they proved. A. These experiments were begun the latter part of 1887 and have been continued to date. The first report was made in 1890. The object sought was to find out the way

405 in which the organic matter in sewage can be completely oxidized and to learn what could be accomplished by filters composed of various Massachusetts soils.

As sewage cannot be purified without being nitrified, the conditions most favorable to the
406 action of the nitrifying organisms were regarded as essential.

As would be expected, the old facts mentioned by Frankland and Warrington were demonstrated again, that flowing sewage over porous sand strains out a large quantity of the suspended matters and finally clogs the strainer and
407 the effluent will then be as impure as the applied sewage; but it was further found that if only so much sewage be applied as will pass through the sand and allow the screened matter to dry up or become oxidized, the operation may be carried on indefinitely.

A filter five feet deep of wash gravel stone,
408 dosed nine times a day with crude sewage at the rate of 126,000 gallons per acre daily, removed ninety-eight per cent. of the organic matter represented by the ammonias and destroyed ninety-nine per cent. of the bacteria.

These results conclusively showed the essential character of intermittent filtration, so called, to
409 be bacterial. It was not a straining process. Small quantities of sewage hourly applied over the whole filter surface, covered each stone with thin films of liquid, exposed it to contact with air held in the spaces between the stones within the filter, and within twenty-four hours, the time required for the liquid to pass through the filter,

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the organic matter was oxidized. The stones were as clear after a year's use as in the beginning. The action was not mechanical, but chemical and bacterial, by which the organic substances were reduced to mineral products, the effluent in every respect comparing with the water in wells and for drinking purposes. 411

An intermittent sand filter, which removed ninety-nine per cent. of the applied organic matter, was later operated continuously like a sand water filter. The surface was covered with sewage excluding air and filling the spaces with liquid. When so operated, purification ceased.
The essential difference between the intermittent 412
and the continuous filter was exclusion of air in the latter.

Instead of Mr. Dibdin's forecast, that the time would come when it would be found practical to cultivate a special organism and introduce it into the sewage coming true, the Massachusetts experiment proved Warrington's position to be cor- 413
rect, that the bacteria effective for the purpose are found to be freely present in the sewage and merely required the necessary conditions to enable them to accompish their work.

Recess until 2 o'clock.

After recess. 414

Q. 20. What followed the publication of the experiments of the Massachusetts State Board of Health? A. The publication of the Massachusetts experiments was at once followed by efforts on the part of the London County Counsel to obtain along the same lines reliable working data on filtration based upon something more than mere laboratory trials.

In March, 1891, Mr. Dibdin was directed to conduct a series of experiments as to the best methods of filtering the sewage effluent of the northern outfall precipitation works at Barking.

416 Preliminary tests during 1892 proved coke-breeze to be the most suitable material for the trial on a large scale. This next experiment was made with a one-acre filter. It began in 1893 and was continued through the autumn of 1895, when Mr. Dibdin made his report.

The chemically clarified sewage treated was
417 passed on to the acre filter at the rate of 1,000,000 gallons daily. The method of operation was novel. The liquid was allowed to fill the filter as quickly as possible to just level with the surface, then allowed to remain standing in the filter for one hour, when it was drawn off with the least possible delay. The filter so worked was
418 given a period of one day's rest each week. The conclusions were, that *clarified* sewage may be purified to any degree, the amount of purification depending upon, first, the length of time sewage is held in contact in the filter, and, second, the length of time allowed for *aeration*.

In no way did these principles differ from those
419 ennunciated in the Massachusetts Reports, but Dibdin's methods of obtaining contact—by means of gates instead of frictional resistance of the filter material—was new, and later gave to the structure the term "Contact beds," although Mr. Dibdin designated them "Bacterial filters."

From the experiments with *clarified* sewage Mr.

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Didbin reasoned that if the organisms had been able to accomplish so great a destruction of the fine suspended matters in the *clarified sewage*, why should they not be equally potent for the destruction of the larger particles in *crude sewage*, which in the aggregate from what is known as "sludge." It was
known that if these coarse matters were placed 421
on the fine beds they might speedily accumulate on the surface thereof and form a deposit of putrifying matter. By making the bed of coarse material the sludge would be able to penetrate into the filter, settle on or be attached thereto and there be subjected to aerobic bacterial action.
These considerations led to the construction of 422
the first coarse sludge bacterial filter of the Dibdin type. It was brought into use November 20, 1896, at Sutton, England. The effluent therefrom was treated in a secondary bed of fine material.

Mr. Dibdin's report to the London County
Council was dated from 40 Craven Street, W. C., 423
October, 1895, and was entitled "Report by the Chemist on the Experiments on the Filtration of Sewage Effluent During the Years 1892-3-4-5." It was ordered printed by the Main Drainage Committee and has been very widely circulated in various countries.

Q 21. What was generally known about the 424
art of purifying sewage by bacterial processes at the close of the year 1895? A. In answering this question I wish to have it understood that the term "purification" embraces all processes involved in the reduction of the impurities, solid or liquid, in sewage from their organic form to the

simplest or mineral form, which mineralization cannot be accomplished without the agency of nitrifying organisms.

At the close of 1895 it was generally known in
respect to slow filtration by those best qualified
and practicing the art, or following the Massa-
426 chusetts Reports, that *fresh* sewage contains sus-
pended organic matter of coarse character which
are readily strained out, remain on the surface,
clog the filter, retard the flow of the sewage into
the filter, prevent proper *aeration* and interfere
with purification.

In *stale sewage* the suspended organic matters
427 are more finely divided—mechanically, chemi-
cally and bacterially—so that less surface clog-
ging occurs, the larger percentage of the solids
passing into the filter where they are changed
into inorganic form and pass away in the effluent
or into the air as gas.

Further, that clogging is always in proportion
428 to the sludge, that the amount of sludge and
sewage varies, that sewage will in time clog a
filter unless great care is used, that a greater per-
centage of sludge is stored at a high rate than
a low rate, that the same quantity stored causes
more trouble at a high rate, that a clog sand fil-
ter will become slowly oxidized when rested and
429 that permanency is independent of size and ma-
terial, but depends on the treatment.

It was generally known, apart from the Dibdin Experiments and before them, in respect to rapid filtration by sand of sewage from which the sludge had been removed, that a rate of from 160,000 to 240,000 gallons per acre daily of set-

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tled sewage, from 200,000 to 360,000 gallons per acre daily of chemically subsided sewage, that 300,000 per acre daily of coke-strained sewage, and that 650,000 gallons per acre daily through sand and 700,000 gallons per acre daily through coke of sewage first treated by rapid filtration
through coarse gravel aided by a current of air 431
drawn downward, could be indefinitely maintained.

It will be noticed that the *indispensible element* of all these accellerated processes was the *preliminary* removal of the sludge.

Mr. Dibdin's departure in 1896 from this principle was radical. His sludge contact filter was 432
considered a doubtful experiment by many. Even in the Massachusetts rapid and forced aeration filters not all the organic matters was destroyed. Some remained in the filters and some came off in the effluent and went onto the surface of the fine secondary bed, limiting it to an extent.

As was expected, the Sutton "contact filter" 433
overshot the mark, accumulated organic matter and had to be subsequently overhauled, but it did draw attention to possibilities of this form of filter hitherto unattempted in practice. Consequently it comprised one of the progressive steps in the bacterial treatment of sewage. Especially did this ex-
periment call attention in England to the necessity 434
for preliminary removal of suspended solids from sewage in connection with the bacterial purification of sewage by filtration. Thus during the last decade of the century, the old problem of the early fifties of sludge disposal once again demanded all absorbing attention.

Q. 22. Please state what you know, or what information you have about the use of tanks in connection with the disposal of sewage? A. The use of tanks in connection with the disposal of sewage, especially on a large scale, is closely connected with the history of sewers in England. The period
436 in which sewage disposal has been in process of marked evolution is divided into three distinct epochs, each marked by a dominant opinion as to the essential object of the disposal.

In the first period, from 1847 to 1857, it was thought of first importance to secure prompt removal of sewage from the neighborhood of dwel-
437 lings and to dispose of it into rivers or onto land in which latter case in consequence of doubts as to the effect upon public health of sewage irrigation, its delivery onto land was thought best accomplished by underground pipes and distribution by hose or jets, thus affecting aeration.

The second period, between the years 1858 and
438 1870, witnessed the abandonment of the idea of injury to health by sewage irrigation, and the growth of the belief that ideal sewage disposal should aim at the profitable utilization of sewage, while at the same time protecting the rivers from contamination.

In the third period, from 1870 to the present time,
439 the dominant idea, as expressed in official publications and by legislation, has been that the prevention of stream pollution is the in dispensible requisite and prime object of every efficient sewage disposal system.

Q. 23. What was the practice in the use of tanks during the period from 1847 to 1857. A. In 1847

it was made compulsory in England to abolish all cesspools, tanks or middens and priveys, and to use sewers in their stead. Cesspools were then very numerous in thickly settled communities and the periodical cleaning out of the offensive matters therein was a nuisance so great as to cause the en-
actment of the law of 1847, which was followed 441
about 1850 by a general adoption of sewer systems. These sewers removed the nuisance from the vicinity of dwellings to their outlets. Then began in consequence on a large scale the pollution of the rivers of England.

The Town's Improvement Act, of 1847, provided
for the method of getting rid of sewage without 442
any profitable return—the local authorities being empowered to discharge sewers into the sea or any public river—and also provided for a profitable method of disposal by conveying sewage to a convenient site and irrigating for agricultural or other purposes.

Under the profitable method the local authorities 443
were required to make such reservoirs, sluices, and other works as should be necessary for cleansing the sewers, and the filth so collected was to be the property of the local authorities who could sell or dispose of it as thought advisable.

So tanks and deposit sewers and receiving reser-
voirs were built and plain subsidence was used or 444
the separation of solids from liquids was hastened by the use of chemicals. The profit from the sale or utilization of these solids was the main object sought.

The first official statement of importance with respect to tanks was made by Mr. Henry Austin in

445

March, 1857, in a report to the General Board of Health, on "The Means of Deoderizing and Utilizing the Sewage of Towns."

The object of this report was to present the best practical mode of rendering outfalls of drainage innocuous and of realizing from sewage the highest
446 possible value. Mr. Austin divided the methods of fertilizing land by sewage manure into two classes, which he designated the solid method and the liquid method respectively. The solid method he divided into three parts, first, the precipitation of solid matters held in mechanical suspension by the use of various chemicals; second, the separation of solid
447 matters by straining or filters and their subsequent admixture with deoderizing material, and third, simple deposition and draining off of liquids from the solid mass.

I have a copy of Mr. Austin's report before me. It is addressed to the Right Honorable, The President of the General Board of Health, by Henry Austin,
448 C. E., Chief Superintending Inspector of the Board, London. Printed by George E. Eyre and William Spottiswoode, printers to the Queen's most execellent majesty, 1857.

Speaking of the first class, Mr. Austin states on page 19, that by the number of patents granted for the general treatment of night soil for the manu-
449 facture of solid manure, he judges that the subject has engaged considerable attention since 1835. He gives a plan, marked No. 1, entitled, "Clifton Union. Sketch showing deoderizing apparatus." For convenience in handling, and for purposes of reproduction, I have had a tracing made of this plan, which I now produce.

F. Herbert Snow. 450

Mr. Austin describes the Clifton Union Works which comprise mixing cisterns, the contents of which were alternately run off into one of two tanks for settlement. These tanks are shown in duplicate of masonry, arched over and made air and water tight, having a non-disturbing inlet, submerged, and
consisting of a conduit extending the entire width 451
of the tank and having throughout its entire length a series of slots or apertures delivering the sewage therefrom to the tank. This conduit as shown by the plan, was on the outside of the tank.

In reference to the second class, Mr. Austin presented a plan marked # 2, entitled "Cheltenham
Sewage Works." For convenience in handling and 452
for purposes of reproduction, I have had a tracing made of this plan, which I now produce.

On page 32 he describes the works at Cheltenham. They consisted of a series of tanks in duplicate below ground, and covered over by a building. The sewage passed out of the first and second tanks,
through outlets comprising chambers located within 453
the tanks and extending nearly the whole width of the tanks and from the top to the bottom thereof, built of two-inch boards, two feet apart, perforated, and enclosing coarse gravel. These outlet chambers, or conduits, acted as strainers. By their use, it is stated on page 32:

454

"The great bulk of the matters in suspension is separated and retained. * * * * the heavier matters of the sewage deposit themselves at the bottom of the tanks, but a large proportion of the solids forms itself into a floating body, and accumulates to about eighteen inches thick on the surface. The liquid is conveyed from the angular filters in the upper tanks by a line of pipes in each division."

455 F. Herbert Snow.

The effluent from these tanks received lime in the third tank and passed out of it through outlets (filters) extending the entire width of the tank and to about one-half its depth. The plant is in duplicate, as shown on the plans and was operated on the continuous principle. The tanks are stated to have been
456 emptied of their solid accumulations after about every eight weeks of continuous use. These solids were raised up from the tanks and removed from the building to beds outside in the adjoining yard, where they were mixed with ashes to facilitate further handling.

Mr. Austin also presented a plan, # 3, entitled,
457 "Sewage Works Ely." For convenience in handling, and for purposes of reproduction, I have had a tracing made of this plan, which I now produce.

Mr. Austin describes these works on page 35.

These works comprise masonry tanks in duplicate, being arched over and made tight, having a submerged inlet and an outlet, consisting of a filter of
458 charcoal and sand, extending the whole length and breadth of the tank and disposed horizontally in the tanks at the springing line of the arch, the same being always submerged. The deposits, I understand, were daily removed and utilized for manure. I will now quote from the conclusions of his report, page 89:

459 "That in order to avoid all further risk of injury to health, whether from discharge of the sewage into the rivers and streams, or from its application to the land, it appears desirable that the solid matter should in every case be separated from liquid sewage at the outfall, and that a cheap portable manure should be manufactured therefrom for use in the immediate neighborhood. * * * That the liquid portion of the sewage, thus cleared of its

solid matter, but still retaining its chief value as manure, might then be applied with benefit to the neighboring lands in any quantity; * * * * That the distribution of manures in a liquid state by the hose and jet from a system of underground pipes on the land, has been found by the experience of several years, upon farms in England and Scotland most advantageous, * * * * That in 461
any neighborhoods, however, where no opportunity exists for this beneficial irrigation, the liquid sewage, before being discharged into rivers or streams, should, after separation of the solid matter, be treated with lime or other deoderizing and precipitating agents."

Mr. Austin made recommendations and submitted a plan, which he proposed for general adoption in England. The plan is numbered 6, entitled 462
"Proposed sewage works." For convenience in handling, and for purposes of reproducion, I have had a tracing made of this plan, which I now produce.

I will now quote from page 79 of Mr. Austin's report what he said about the proposed arrangement for separating the solid portion of sewage 463
from the water in which it is conveyed:

"The great bulk of the solid matter, when the sewage comes to comparative rest in the reservoir, divides itself into two bodies; the heavier particles at once deposit themselves at the bottom, and the lighter portions collect, in a solid floating mass, on the surface. It appears to me that the chief proportion of these matters may be intercepted in the first 464
tank A, (Drawing No. 6) both above and below, without a filter, by a simple division, B, with basketwork and perforated boards in the middle, allowing the water to pass through only at a certain depth beneath the surface.

The second tank or reservoir, C, need not then be so deep or so large as the first. At the end of it filtering materials of different kinds should be

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arranged, through which the sewage would pass
laterally: 1st, coarse screened gravel, beach, or
broken stone; 2nd, gravel of medium coarseness;
and, third, some finer material. And there would
be much advantage in having this filter, D, shallow
and broad, rather than deep and narrow; the sur-
face-water only would pass away, and thus allow a
466 further deposit from the main body before filtra-
tion, * * * * a very small area of filters so
placed would be found sufficient for all practical
purposes.

The reservoir for deposition after the addition of
the lime should be considerably larger than that at
Cheltenham. There is not time, in that case, for
the precipitation to take place. The lime and
remaining sewage flow off in suspension to the
467 stream, and have an unsightly effect * * The
admixture being made as the sewage flows into the
reservoir at each end, I propose that it should be
intercepted by a fender, that it may not disturb
the main body of water, and that the discharge to
the outfall should take place over a weir, allowing
only a surface film of the water, from which the
lime has descended, to pass over."

Q. 24. Did Mr. Austin's proposed tank system
468 embrace principles which have been present in
tanks since that time? A. Yes, the elements of his
typical tank system, variously modified to meet lo-
cal requirements, have been followed out in prac-
tice, even up to the present time.

Q. 25. State what are the essential elements
469 recognized in the Austin Tank System and what ar-
rangements were provided to accomplish the pur-
poses? A. His system recognized that in a sub-
sidence tank there may be:

1st. A deposit of solid matter on the bottom.

2nd. An accumulation of a solid floating mass on the surface.

3rd. The necessity for drawing off the liquid between the top and the bottom.

4th. Provision for a submerged non-disturbing outlet across the entire width of the tank below the top, and above the bottom.

5th. Desirability of drawing off upper layers of liquid from some of the compartments through 471
strainers.

6th. Placing of strainers at the end of the tank, forming thereby an outlet chamber, extending across the entire width of the tank and to and depth desired.

7th. Necessity for both a non-disturbing inlet and outlet in some tanks. 472

8th. Use of baffle board or fenders at the inlet and a weir at the outlet end to accomplish non-disturbance and promote separation of the solids from the liquid sewage.

9th. Provision for removal of the accumulated solids from the tanks.

Adjourned to Saturday June 10, 1905, 10:30 473
A. M.

New York, June 10th, 1905, 10:30.

Met pursuant to adjournment.

Present, Counsel, as before.

Direct Examination of Mr. Snow, continued:

Q. 25. What was the practice in the design and 474
use of tanks in the second period, being the years 1858 to 1870? A. During this period, British patent, No. 232, January, 1860, was granted to Thomas Walker for an apparatus to promote plain subsidence, in which the sewage is conducted to a small flowing pool or conduit, whose object is to

break up or moderate the velocity and let it flow
into the large subsiding pool of flowing sewage,
as quietly as possible, which is done by providing a
partition wall between the two pools with a pas-
sage or long, narrow and horizontal opening from
the inlet pool or conduit into the lower part of the
476 subsiding pool, said opening extending the whole
width of the bottom of said pool; the subsiding
pool being formed with an inclined bottom, serving
to intercept the suspended matters in the water,
while on its way from the entrance to the exit, and
increasing the facility for emptying the pool of the
solids, the overflow being over an extended line
477 the width of the pool, this outlet overflow being
a weir and affording natural aeration. The ap-
paratus is arranged in duplicate.

Again, in 1864, British patent, No. 2329 was
granted to Thomas Walker and Thomas Ferdinand
Walker, for improvements in apparatus where sew-
age matters are collected in reservoirs in order that
478 the fluid portion thereof may be separated from the
more solid by subsidence, the object of the inven-
tion being to separate the heavier solid matters
by causing them in passing into the subsiding res-
ervoir to pass through a trough, chamber or con-
duit, extending the whole width of the tank by
which the heavier solid matters may be arrested,
479 whilst like bodies in suspension, such as paper, rags,
and fibrous matters, will pass over the wall form-
ing one side of the trough, chamber or conduit, and
will be intercepted by a grating provided for that
purpose. The sewer or delivery conduit is sub-
merged and has several openings into the collect-
ing trough, chamber or conduit, said openings be-

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ing below the top and above the bottom thereof, forming non-disturbing inlets and serving to trap the drains and prevent the return of foul smells up the drain or sewer. The heavier solid matters of the sewage are designed to be arrested in the said trough, chamber or conduit, and sink to the bot-
tom thereof, while the lighter matters pass with 481
the more liquid portion of the sewage over the wall, forming one side of the said chamber and be intercepted by the grating, baffle-board or partition extending downward from the top into the water, serving as a submerged outlet, extending the entire width of the tank. In going into the larger settling
tank, the sewage passes down in a conduit in the 482
tank and extending the entire width of the tank, and having an opening for its entire width in the bottom thereof, which opening is below the top and above the bottom of said tank, said inlet conduit in the tank serving as a submerged non-disturbing inlet in which the light suspended matters in the
sewage are intercepted by a horizontal screen laid 483
over or in the said opening in the bottom. The tanks are in duplicate, operate on the continuous principle and the effluent flows over a weir at the opposite end of said tank, said weir extending the entire width of the tank and serving to aerate the effluent naturally.

British patent, No. 3203 was granted in 1868 to 484
Gavin Chapman for improvements in treating sewage in order to obtain valuable products therefrom, in which it was desirable that the portion of the ordinary sewage comprising the excreta from water closets, urinals and the like, be kept separate from the bulk of drainage water which enters ordinary

sewers, either by means of separate sewers or otherwise. The richer sewage thus obtained was then collected in large tanks or reservoirs whose object was to retain the sewage during three or four days, or until it became decomposed, the decomposition being hastened by always leaving in the tanks a
486 quantity of previously decomposed sewage and by maintaining the sewage at a temperature of from 70 to 80 degrees Fahrenheit.

British patent, No. 3562, was granted in 1868 to Thomas Smith and John Van Norden, Balalgette, for improvements in deodorizing and manufacturing manures from sewage, according to which in-
487 vention the sewage or other fluid is introduced into a settling tank through openings in the wall of the tank at different heights, so as to obviate the disturbance caused in the process of precipitating the solid matter by the falling of the sewage stream from the upper surface of the tank wall. The said several openings for the admission of the fluids
488 are closed and opened by sliding traps actuated by floats. The sewage from the sewer, after being mixed with deodorizing material, falls into a tumbling bay or inlet chamber, extending the entire width of the tank, from which it enters the tank through the said series of non-disturbing openings in the side of said chamber, said openings being
489 below the top and above the bottom of said tank. When the semi-fluid deposit has accumulated in the tank, it is drawn off by a pipe and run on to drying beds outside. The liquid escapes on the opposite side of the tank from the inlet through a submerged outlet comprising a chamber or conduit, having a slot or opening extending the entire

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width of the tank and being disposed below the top and above the bottom thereof, through which the sewage flows out and up and over a weir into a second tumbling bay or chamber, from which it enters into a second settling chamber in like manner as the first.

British patent, No. 364, was granted in 1870 to 491
George William Wigner, for improvements in the mode of and apparatus for treating and purifying sewage, consisting, first, in the use of a pit or tank, termed "catch-pit," through which the sewage is caused to pass slowly on its way from the main sewer or other source to the mixing pit. After
the sewage is mixed with chemicals, it is caused to 492
flow to the precipitating apparatus, consisting of a series of settling tanks having sloping bottoms and channels for the ready conveyance away of the mud which settles from the sewage. These tanks are in duplicate, and built of masonry and are arched over. The inlet thereof, consists of a conduit,
extending across the whole width of the tank on 493
the outside and communicating with the tank through a series of openings in the wall, dividing the inlet conduit from the said tank, these series of openings extending throughout the entire length of the said conduit and the entire width of the said tank, said openings being below the top and above
the bottom of the tank, being always submerged 494
and non-disturbing in their action. As the sewage flows from one set of tanks to another, it passes over transverse partition walls, and the effluent passes out of the tanks over a weir, thus coming in contact with air and light and falls into a collecting conduit over the opposite wall of which it

flows to a filter. This wall acting as a weir and aerating the sewage effluent and after being filtered, in its purified state, the effluent passes over another weir into the river or other outlet.

I will cite two instances of the use of tanks.

At the Croydon Sewage Farm, since 1861, there
496 have been in use two small settling tanks into
which the sewage flows before going on to the land.
These tanks are in duplicate, provided with screens
and scum-boards and are used on the continuous
method.

At Aldershot Camp Farm, built in 1864, there
are three sets of tanks, worked on the continuous
497 principle and in pairs, each pair of tanks being
provided with a fixed bar screen, through which
the sewage passes prior to entering the tank. The
tanks are provided with scum boards and the sew-
age flows out over a weir or tank sill and is aer-
ated, whence it goes to the irrigation beds. A
plan of the tanks at this farm and at Croydon is
498 exhibited in the Royal Commission on Sewage
Disposal Report, Volume 4, 1904.

Q. 26. State what was the practice in the design
and use of tanks in the third period, namely, from
1870 to the date of the patent in suit, or to the
present time. In answering this question, please
refer to any patents or publications of which you
499 may have knowledge? A. I will refer first to an
innovation established by Dr. Alexander Muller.
He made some experiments in 1869, which he pub-
lished in 1873 in "Landwirthschaftliche Versuch-
stationen," Vol. 16. I have a translation of this
article, or parts of it, before me, in the Journal of
the Society of Arts, Vol. XLVI, from November 19,

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1897, to November 11, 1898, London, published for the Society by George Bell & Sons, 4, 5 and 6 York Street, Covent Garden, 1898. The article from which I wish to quote, appears on page 165 of the said Journal, and is signed by H. Alfred Roechling.

"On page 263 of this publication, Muller remarks as follows: 501

"'The contents of sewage are chiefly of organic origin, and in consequence of this an active process of decomposition takes place in sewage, through which the organic matters are gradually *dissolved* into mineral matters, or, in short, are mineralized and thus become fit to serve as food for plants. To the superficial observer this process appears to be a chemical self-reduction; in reality, however, it is 502
chiefly a process of digestion, in which the various —mostly microscopically small—animal ad vegetable organisms utilize the organically fixed power for their life purposes.'

"And again:

"'The decomposition of sewage in its various stages is characterized by the appearance of enormous numbers of spirillae then of vibrios (swarming spores) and finally of moulds. At this stage commences the reformation of organic substance 503
with the appearance of the chlorophyl holding Protococcus, &c.'"

In 1878 Dr. Muller took out a German patent, No. 9792, entitled, "A Process of Disinfecting, Purification, and Utilization of Putrescent Waste Liquid (or Liquid Sewage) by the Rational Cultivation of Fermenting (leaven-like) Organisms," 504
patented in the German Empire from December 11, 1878.

At this time the adoption of flush sewers in towns was becoming quite general, but at the same time the demand for the water required for flushing the sewers was also increasing, and this re-use

of the water required that it be first purified; but the difficulty lay in the organic matter in the sewers and the putrefaction involved. Up to this time attempts at removing the nuisance by dilution or chemical precipitation or filtration or irrigation, had proven more or less failures, and investgators
506 had concluded that on purely mechanical or chemical lines the object aimed at could not be obtained.

I will now quote a few lines from the specification of the Muller patent, to show the object sought and the method of securing it by the said invention:

"Now whereas the former disinfecting methods
507 had for their essential object to obviate as far as practicable any phenomena of putrefaction corruption or decomposition) the process herein described, on the contrary, aims at the methodical cultivation of those small "leaven-like" organisms to the viability of which modern science has traced the so-called 'self-unmixing' processes, namely, acidification, fermentation, putrefaction, decay or the like, in accordance with the rules of physiology, with a
508 view to bringing them into requisition in the task of precipitating out the liquid waste-substances or bringing about their complete mineraliztion (i. e. reduction to simple inorganic compounds)."

* * * * * * * * * * * * * *

"The mechanical and structural arrangement required in carrying out this process are extremely simple. They consist of three or four basins (or
509 baths) of at least one metre's depth for the digestion and defecation of the waste-liquid. Altogether they should have a sufficient capacity for receiving a full day's output in waste liquid, and be provided with means for its continuous admission and discharge. They are lifted out of the ground and receive a floating top-cover of porous material (such as straw, chaff, froth, scum, &c.), so as to retard cooling and evaporation.

"Any effluvia from putrefying matter likely to prove objectionable, as noxious gases and vapors generally, are got rid of by being sent through a system of drain-pipes which are so laid down in a field that normally they remain dry, or at all events are never entirely filled with water.

"To the said basis or baths at any desired distance there are joined (or connected) filters of 511
coke-dust, coal, sand, or ground mould, which should be properly ventilated by means of drains open on both sides, and should in capacity represent about fifty times the volume of a day's discharge of waste liquid. * * * * * * *

"This process is mainly intended for disembarrassing beat-sugar works from the liquid waste which, in their case, is particularly objectionable. Its application to the treatment of the liquid 512
waste of starch factories, paper mills, breweries, distilleries, malt works, dye-works, cleansing works, laundries, leather dressing works, and even to the treatment of city household waste, is affected substantially in the same manner and involves but slight modifications according to the nature of the particular liquid to be treated."

The Muller process was a combination of what is now known as septic action, with aeration and 513
filtration.

Another innovation was introduced in 1881 by Louis Mouras of France, who patented an improved cess-pool, both in that country and in England, in 1881, and on November 28, 1882, he was granted a patent in the United States.

Recess. 514

This apparatus was fully described in the "Minutes of Proceedings of the Institution of Civil Engineers," London, 1882, Vol. XLVIII, page 350. This volume was edited by James Forrest, Assoc. Inst. C. E., Secretary, published by the Institution, 25 Great George Street, Westminster, S.

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W. The article which I wish to quote in full, beginning on page 350, is as follows:

"Mouras' Automatic Scavenger.
By Abbe F. Moigno.

(Cosmos, Dec., 1881, p. 622, Jan., 1882, p. 97.)

"The author describes the dangers to public
516 health caused by a concentration of large populations in cities, and calls attention to the want of success which had attended all the known systems of sewage purification and utilisation. He quotes the opinion of M. Allain Targe to the effect that all the plans hitherto investigated by the authorities of the City of Paris had utterly failed, and announces the invention of M. Mouras as 'a complete solution of the problem which for cen-
517 turies had been an insolent menace hurled in the face of all humanity.' He says that the apparatus which has been in use by the inventor for twenty years is 'the most simple, the most beautiful, and, perhaps, the grandest of modern inventions,' and that, in speaking of it in these terms he is under—rather than over—stating his case, for each day reveals a new cause of perfection in this mysterious contrivance. The description has been de-
518 layed for some months owing to certain technical errors in the applications for patents in France and in other countries, but these difficulties have now been removed, and he is at liberty to publish the nature of the invention. Before doing so he alludes to a fact which, though little known, is extremely instructive. Naturalists have introduced aquariums, containing either fresh or salt-water, filled with animals, for the purpose of
519 study, and the curator of the Zoological Gardens of London, who first employed them, was surprised to see that his cherished fishes speedily died, and that his aquarium was in reality only a tomb. It was an aggregation of living animals in which the functions of the scavenger were not provided for, and the fish died, poisoned by their own unhealthy dejections. What was to be done? It was found that by invoking the aid of molluscs,

zoophites, and aquatic plants, which live upon and decompose animal dejections, the necessary scavengers were obtained and the mortality ceased. Here then was a fine example to follow. Eliminate the human dejections by disinfecting them and rendering them fertile. Let everything be transformed on the spot, let everything be emptied away without any loss—the whole made 521
useful, and thus turn death into life All this the automatic scavenger of M. Louis Mouras effects for human populations, however numerous and however dense they may be. The scavenger is in fact—1st. Hermetically sealed and closed by the most inviolable of seals—the hydraulic seal; its contents are therefore shut off from all possible contact with the surrounding atmosphere. 2nd. It is absolutely inodorous, and renders every kind 522
of infection impossible. 3rd. By a mysterious operation, and one which reveals an entirely novel principle, it rapidly transforms all it receives into a homogeneous fluid, only slightly turbid, and which holds all the solid matters in suspension in the form of scarcely visible filaments. There is moreover no deposit of any kind, either in the discharge-pipe or the sewer. 4th. It is self-emptying and continuous in its working, that is to say, for each new addition from the soil-pipe 523
an equal volume of the contents, duly transformed and prepared, passes away into the sewer. 5th. The liquid which escapes, while it contains all the organic and inorganic elements of the foeces, is almost devoid of smell, and can be received into a watering-cart for horticultural purposes, or may pass away into the sewers for use in irrigation. The Author refers to the great advantages result- 524
ing from the foregoing facts, and states that they are obtained by means of an inexpensive and very simple addition to the appliances already in use (in France). All that is needed is to render the cesspool water-tight, to slightly prolong the soil-pipe so as to dip a few inches into the liquid contents of the cesspool, which are kept at a uniform level, and to add a discharge-pipe, which shall

also have its upper extremity beneath the surface of the liquid, but so contrived that it dips slightly downwards, the other end being carried into the sewer, or into a receptacle for liquid manure. Having thus fitted up the apparatus, a constant and automatic scavenging process is the necessary result of the impenetrability and irresistible incom-
526 pressibility of the liquid contents.

"In a subsequent number M. Moigno describes the action of the cesspool by reference to a woodcut. He states that almost any material may be employed in the construction of the tank, the only condition being that the receptacle must be absolutely impervious to water and to air, and he states that arrangements are being made to supply them either in zinc or in galvanized iron of
527 every size and shape. A vessel capable of containing 1 cubic metre (about 220 gallons) is sufficient for a household of from 20 to 25 persons. Passing on to the theory of the action, which is at present obscure, the Author states that it is well known that few things are more insoluble in water than foecal matters, which is due to the fact that they are encased in a species of mucous or fatty envelope, which preserves them from contact with fluids, but he believes that in the air-
528 tight cesspool the solvent action of sulphuretted hydrogen is called into play, and that a species of putrid fermentation is set up which effects the liquefaction of the solid foeces. The liquid flowing from the cesspool has a faint odour of this gas, suggestive slightly of the smell of vulcanized india-rubber. But this is but a hasty conclusion, and the whole matter is well worthy of the con-
529 sideration of chemists. May not the unseen agents be those vibrions of anaerobies, which, according to Pasteur, are destroyed by oxygen, and only manifest their activity in vessels from which the air is excluded?

"Daily observations conducted with a glass laboratory-scavenger have been made, and from these it results that foecal matters introduced on the 29th of August were entirely dissolved on the

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16th of September. Even kitchen refuse, onion peelings, &c., which at first floated on the surface, descended after a time to the bottom of the vessel to await decomposition. Everything capable of being dissolved acted in a similar way, and even paper wholly disappeared. To test the evolution of gas an india-rubber tube was inserted in the lid of the glass model, but was so 531
adjusted as not to dip into the liquid; to the other end was attached an empty bladder. Not only did this bladder continue without signs of inflation, but it became, if anything, more exhausted consequent upon the absorption of oxygen. This experiment is of great importance, and is a complete answer to the fears expressed by Messrs. Alphand and Durand-Claye (engineers to the City of Paris), that gases might be given off 532
which would exert an injurious pressure on the structure. On the free admission of the atmosphere a speedy change was observed; at first small bubbles began to form, and on closing up the aparatus the bladder became about one-third full of noxious gases. The exclusion of the atmosphere is therefore a necessary condition of success. It has been also noticed that the more water is passed into the cesspool the more rapid 533
and complete is the destruction of the suspended matters, and it remains to be seen what quantity of water can most advantageously be used to give the best results on a large scale. The Author concludes with an estimate of the cost of applying the system to the whole of Paris. There are 80,000 cesspools of all sizes in the city, and he suggests that the municipal authorities should acquire the right to use the invention for the 534
whole term of the patent for £2 per cesspool, and charge an annual license fee to each householder of £1. By this means, after the end of the second year, the city would have recouped itself for the first outlay, and would receive for the future an annual payment of £80,000. The work of scavenging would be far better performed than at present, the householders would be saved a vast

amount of trouble and expense, and the foecal matters of the population would become at once available for irrigation. G. R. R."

Mouras French Patent, of which the above article is a description, was No. 144,904, dated September 22nd, 1881. The process sought in Mouras'
536 tank is now known as the septic process. It was an intentional utlization of the natural liquefaction in tanks caused by bacterial action.

As further describing Mouras' tank, I will now quote from Volume LXXII of the Minutes or Proceedings of the Institution of Civil Engineers, published 1883, page 359.

537 "THE THEORY AND ACCURATE WORKING OF THE AUTOMATIC SCAVENGER.

By the Abbe F. Moigno.

(Cosmos-les-Mondes, January, 1883, p. 110.)

"The author states that the only serious objection made to this invention is the following one: Is it not possible to determine beforehand what dimensions should be given to the scavenger in order that, as its name implies, it should continue
538 to work without interruption for an indefinite period? Mr. Mouras, the inventor, has carefully studied this question, and has prepared a complete solution by the facts now brought forward. A table has been constructed for all sizes of tanks, from an area covered of ½ square metre (5.38 square feet), to 20 square metres (23.9 square yards), and for each number of persons contributing to it, from one to two hundred. This table
539 indicates at the same time, (1) the depth the tank should contain of liquid matters; (2) the thickness of the upper stratum of solids undergoing decomposition (desagregation); (3) the depth to which the overflow-pipe must be submerged, and (4) the capacity of the tank in cubic metres. A constant depth of one metre for every size of tank would be all that would be necessary, if nothing but excreta could enter the tank. A small cor-

rection has, however, to be made for detritus and foreign matters. The calculations have been based on an assumed depth of 1 metre, and it has been found (1) that each member of an average population adds daily a volume of foecal matters equal to 2-10,000 of a cubic metre (0.35 pint); (2) that for the complete solution of the
floating solid matters a period of thirty days is 541
required, if the superficial area is such that the thickness of this top layer does not exceed 0.075 metre (2.95 inches). With these facts established, the necessary proportion can be calculated with mathematical accuracy. The Author recapitulates the advantages previously claimed for this invention, and states it to be the only one which renders it possible to send all the dejections, liquid and solid, to the sewers. The Table, which gives
the dimensions for tanks of all sizes, calculated 542
from the formulas which follow, is not suitable for an abstract.

"Assuming the daily volume of excreta per head to be 0.000250 cubic metre (0.44 pint), which is excessive, and taking the base of the tank as equal to one-tenth part in square metres of the number of the contributory population, the depth of the tank p can be ascertained from the following for-
mula p = 1.00 metre × (N x 0.02), N being equal 543
to the number of persons, and 0.02 a constant to allow for detritus. The depth of undecomposed solids may be found from the following formula, E being the thickness of the layer, $E = \dfrac{0.00025 \text{ metre} \times N \times 30}{S}$.

Here S is the area of the base of the tank in metres,
and N the number of persons using it. Finally, 544
the length of the submerged portion of the overflow-pipe is ascertained by the addition of 10 centimetres (3.93 inches) to the above thickness, or a constant depth, in round numbers, of 0.175 metre, say 19 centi-metres (7.08 inches).

G. R. R."

Adjourned to Monday, June 12, 1905, 10:30 A.M.

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New York, June 12th, 1905, 10:30 A. M.

Met pursuant to adjournment.

Present, Livingston Gifford, Esq., for Complainant; C. L. Sturtevant, Esq., for Defendant.

Direct Examination of Mr. Snow Continued:

(Witness continues his answer to Q. 26).

546 As an instance of the practical use of Mouras' apparatus, I will now quote from Volume LXXVIII of the Minutes of Proceedings of the Institution of Civil Engineers, published 1884, page 502, as follows:

"Mouras's Automatic Scavenger."
By E. Thierry-Mied.

547 (Annales Industrielles, August 24, 1884, p. 253.)

"The Author has presented to the Industrial Society of Mulhausen a statement respecting the automatic scavenger, which has been in operation since the middle of the year 1883, at the works of Mr. Herzog at Logelbach, and which has fulfilled all the promises of the inventor. The cesspool with which the experiments were conducted was a cube constructed of brickwork
548 in cement of 4 metres (about 14,000 gallons). It was used for three water-closets, frequented by one hundred and fifty workpeople. When first employed it was three parts filled with water, and has since received a daily inflow of 10 litres of water per head, or a total volume of 1,500 litres of water (330 gallons) per diem, plus the dejections, liquid and solid, of the workpeople. The daily inflow was fairly constant in volume,
549 and an exactly similar quantity of the contents was allowed to escape, maintaining the liquid in the cesspool at a uniform level.

"The arrangement of the inlet and outlay-pipes was in the form prescribed by the inventor.† The liquid issuing from the cesspool was received into a second tank, from which it was distributed over a large meadow and a vineyard. It was quite limpid, of a greenish color, and emitted a

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faint odor of sulphuretted hydrogen, which, however, disappeared at a distance of from 80 to 100 metres; that is to say, at the point where the liquid issued into the open air. At this point the sewage-water assumed a milky hue. The action of the scavenger has been so perfect that the Author is tempted to accept the theory advanced in *Cosmos*, that a complete putrefaction 551
takes place, by which all fecal matters, solid and liquid, textile fabrics, paper, etc., are dissolved in the space of thirty days.

"The chemical changes which go on in the cess-pool may be summed up as follows: Owing to the vessel being hermetically sealed, the phenomena of oxidation are practically prevented, the only available oxygen is that dissolved in the water added daily. The phenomena are simply 552
due to hydrogen.

"Sulphur derived from organic matters and biliary secretions, and nitrogen obtained from the urea and uric acid, give rise to the formation of hydro-sulphate of ammonia. The fatty matters are evidently converted by the free ammonia and the alkaline earths into ammonical and other soaps. The phosphates undergo no change whatever, and the manurial value is undiminished, be- 553
cause the nitrogen remains in compounds easy of assimilation by plants. The Author sums up the advantages of the system in the following terms:—The power of emptying into the cesspool domestic slops, greasy liquids, &c.; the suppression of all ventilators discharging mephitic gases into the atmosphere; permanent scavenging, without manipulation of any kind, and without soiling the premises and the courtyards; the re- 554
covery of a liquid product, of the density of pure water, having a smell greatly changed in character, and which liquid may be at once discharged into a water-course or employed for irrigation.

G. E. R."

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† *Minutes of Proceedings Inst. C. E., vol. lxviii, p. 350; and vol. lxxii., p. 359.*

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The above installation was a practical application of the method of sludge treatment as the "septic process," combined with aeration and filtration.

Mouras's apparatus was fully illustrated and described in "The Engineering News," of April 15, 1882, published in New York, being an article
556 entitled "An Automatic Vault Cleaner." This article was, so far as I know, the first one published in America describing the Mouras putrefactive liquefying process, now called the septic process. I will now quote from this article, page 117:

"AN AUTOMATIC VAULT CLEANER."
557 (Translated for Engineering News.)

"The principles on which M. Mouras bases the action of this machine is that the animal dejecta contain within themselves all the principles of fermentation or dissolution necessary and sufficient to liquefy them, and to render them immediately useful in their return to the soil and without appreciable loss.

"In the figure A is the vault, B the soil pipe
558 from the house, C the siphon discharge pipe, D concrete foundation, E walls, F plastering in cement, G flagstone curbs, H man-hole to the vault, I plug for inspection, J drain-pipe to the street sewer, M box of sand to catch any solids which may accidentally enter through the soil-pipe, N chain holding this box and by which it may readily be turned up to the man-hole and cleaned out, O street sewer with house-drain, P
559 trapped by the sewer water.

"The vault may be constructed of any material which can be made water and air-tight, of a capacity of one cubic meter to suffice for the service of a house of from 20 to 25 persons. The vault being filled with water, the tightness of the construction and the traps cut off all emanations or escape of gas from the interior into the house.

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"After the fecal matters enter the vault in suf-
ficient quantities, the liquid becomes turbid and
of a brown color, but however long continued it
may be used, providing that the urine and waste
waters enter with it, a fermentation takes place
which dissolves all the fecal matters, even the
most solid, into particles or filaments so small as
scarcely to be discernible, without any deposit
adhering to the walls or sides of the pipes. Noth- 561
ing is more insoluble in itself than fecal matter,
as it is covered by an animal grease or mucus,
which prevents the water from acting upon it.
Experiments were made by means of a vault with
glass sides, like an aquarium, perfectly sealed.
There being discharged into this aquarium but
fecal matters and a very small percentage of
water, yet the liquefaction of the excrements was
complete, without any deposition—all remained 562
in suspension. Introduced August 19, the solid
dejecta were completely liquefied by Sept. 16,
with the exception of the undigested matter, such
as seeds and skins of grapes, and some kitchen
refuse of vegetables, such as carrot and onion
peelings. These floated for a time and then fell
to the bottom to await decompisition. Paper dis-
appeared in a like manner. About a liter in bulk
of the urine fecal matter and a little water, taken 563
from the aquarium, exhaled but little odor; di-
luted with 100 times its bulk of water, it was limip
and inodorous. Twenty days in succession there
was thrown into the aquarium, with the ordinary
fecal matter, about 10 liters of a mixture of
urine and soapsuds, so as to render the condition
as near as may be that of an ordinary cess-pool,
and the result was that the fecal matters al-
ways swam upon the surface, forming a sort of 564
scum, never exceeding 5 centimeters in thickness,
owing apparently to the constant dissolution go-
ing on below. On adding 10 liters of water, the
matters not digested, such as vegetables or fruit
skins, disposed themselves on the top in the order
of their specific gravity, and then, after a time,
fell to the bottom to wait their decomposition,

565 which, operated insensibly, but efficiently, the deposit not being sedimentary, but gradually mixing with that above, was discharged with the liquid of the aquarium without any foreign matters appearing in suspension. No pressure from gas is apparent, as was shown by a pipe fixed in the top of the aquarium with a bladder at-
566 tached, not being distended. On taking off the cover H, no bad odor was given out, until the air had time to act, when gas began to rise, and, on closing the opening, the bladder became extended. The operation, to be complete, it would seem the apparatus must be air as well as water-tight. The dissolution of matter seemed more active the greater the quantity of water supplied, which admits therefore of the introduction of house and rain water—but they are not indispensable.''

567 In the published report of the "Seventh International Congress of Hygiene and Demography," held in London, in 1891, Professor L. Pagliani, Director of Public Health at Rome, Italy, read a paper describing his application of a reservoir interseptor made on the Mouras type, and connected with a peat filter. I have a copy of this paper be-
568 fore me, stamped with a rubber stamp, "American Society of Civil Engineers, New York, Aug. 25, 1891," in which he describes the methods pursued by him. The first question with him was to apply some simple apparatus to get a sufficient dilution of the soluble or emulsionable materials from the privy to separate them from the solid and heavy
569 parts; and the second question was to apply a filter which would be sanitary in its operation. I will quote from page 1:

''To solve the first point I had proposed long since and of late tried practically with good results a type of Mouras' reservoir somewhat modified.''

And on page 2:

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"As in every Mouras' reservoir, mine has for overflowing liquid an opening, but provided with a grate, through which can not pass directly those bodies that are floating on the liquid gathered in the reservoir. This opening has the diameter a little less than 5 centm., that is to say, narrower than that of the tube which begins
from it, and continues in other still larger ones, 571
so that what passes through it will surely pass through the next tube. * * * * *

"Experience has proved that such a reservoir can work properly without any inconvenience for a very long period, and perhaps indefinitely when to it is supplied an abundant flowing of water; but if the water be in want, it may happen that the floating layer thickens so in the course of a
few months as to make difficult the further flowing of the successive sewage. 572
In this case, however, to put the apparatus to work again is sufficient to draw off the reservoir some liquid at ¼ its height from the bottom by means of a pipe; the surface of the liquid with its floating solid layer is thus lowered, and by filling again the reservoir with water through the privy pipe a great dilution of the sewage and its flowing is
easily obtained. This operation, even in worst 573
cases, is not to be repeated more than once every three or four months, and it is then of no difficulty in its use."

"To filter the dissolved sewage that is drawn from the said reservoir, Professor Pagliani resorted to peat which seemed to give the best results. These filters were made in masonry compartments.
On page 3 he states as follows: 574

"To get an active filtration I had to set a drain to work in the bottom, as I found it necessary for the peat to be never completely imbued, but to have always a free access of air.

He further mentions three instances of the use on a large scale of the tanks and filters. One at the public health laboratories, one at the School for

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Student Doctors in Hygiene, having a population of about 150, and one in an educational institution having about 300 girls.

These instances are another example of the practical application of the method of sludge disposal now known as septic treatment, combined with
576 aeration and filtration.

Mr. W. D. Scott Moncrieff, C. E., of Ashtead, Surry, England, used the liquefying process in in 1891. He installed a simple upward filter plant at his country home. This installation was in the main, similar to the old-time upward filter. He did not anticipate results which followed. Instead
577 of a mechanical action, he discovered that the apparatus provided a favorable condition for the development of organisms which changed the organic matter into a clear, inoffensive effluent. Straightway, he improved the apparatus, termed it a "cultivating filter" and exploited the discovery of continuous purification of sewage by bacteriological
578 action through aerobic liquefaction.

In the Autumn of 1892, through the assistance of Dr. Sims Woodhead, he secured the services of Dr. Houston, and together they set to work to find out what was going on. A laboratory was established at Ashtead and the various bacteria were identified. In 1894 Mr. Scott-Moncrieff was enabled to
579 positively name certain liquefying organisms, some aerobic and others anaerobic, whose cultivation it is the object of his invention to accomplish.

At that time the system was at work at various country houses in England.

Mr. Scott-Moncrieff was granted a United States patent in 1894, No. 530,622, dated December 11,

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1894, application filed November 21, 1892, for apparatus in which liquefying organisms are intentionally utilized, it being a practical application of what is now known as septic treatment of solids combined with aeration and filtration.

In support of these statements, I wish to quote from extracts of various British press publications: 581

"Pall Mall Gazette, Sept. 24, 1892.

"The advantages of sewage treatment on this system are, on the face of it, very great. It would get rid of the heavy expense of chemicals and the nuisance arising from the treatment of sewage sludge, as in the case of Mr. Moncrieff's filter there is no sludge, besides which there is 582 no appearance of sewage."

"Suffolk Times, Sept. 30, 1892.

"Mr. W. D. Scott-Moncrieff, C. E., built for himself a mansion at Ashtead, in Suffolk, determining to dispense with the ordinary cess-pit, as being at once unsanitary and objectionable in many ways. Instead he laid down a filter bed, longitudinal in shape, about 3 ft. deep, 2 ft. 6 in. 583 wide and 15 ft. long, and designed for upward filtration on an entirely novel plan. Into one end of this bed the sewage and waste water of the establishment are discharged without the intervention of any trap, grating, or other mechanical appliance whatever. Both solids and liquids find their way upwards through a false bottom by the natural flow of the water into the filter bed, and nothing more is seen of them—the surface being 584 perfectly dry and pure—until, at the opposite end, a stream of water, more or less clear, discharges itself into a second and subsidiary filter bed, from which an effluent, as unlike an ordinary cesspit overflow as could be well imagined, is discharged into a neighboring ditch.

"Mr. Moncrief did not anticipate the result which actually followed. Instead of the inde-

585 scribable nastiness of sewage matter, the effluent was almost pure. This could not be due to mechanical means. What had happened? There is every reason to believe that the change was due to the destruction of sewage matter by the life processes of micro-organisms contained in the filter bed."

586 *"Engineer,* Oct. 14, 1892.

"Cultivation Filters for Sewage Disposal.

"Mr. Scott-Moncrieff has for some time been carrying out a practical investigation on what may be hereafter known as the system of 'Cultivation Filters.' For some time past the theory has gradually obtained credence that the natural destruction of the organic matter in sewage and its consequent nitrification, as obtained in the
587 action of aerated soil, is due to a bacteriological fermentation, and the results of the Massachusetts experiments prove conclusively that this action takes place only in the upper strata of highly porous soils. The investigations of biologists have proved that this fermentation is due to the action of a micro-organism which they have named 'bacterium termo.' M. Pasteur has further shown that this organism depends for its
588 existence on oxygen, and he therefore describes it as an 'aerobian.' Mr. Scott-Moncrieff has discovered, by a series of experimental investigations, the conditions necessary to develop and cultivate this germ, and, as a natural sequence, a system of sewage purification which promises to dispose of the problem, so far as isolated houses are concerned, and will bring the reign of the cesspool to a speedy termination."

589 *"Hampshire Advertiser,* July 26, 1893.

"The Sewage of Lyndhurst.

"13 Victoria Street,
Westminster, S. W.,
July 1st, 1893.

"Dear Sir:

"I have pleasure in giving you the following information regarding the bacteriological puri-

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fication of sewage by means of the Scott-Moncrieff system of 'cultivation filter beds,' which is, in my opinion, the only natural process extant by which sewage can be purified without chemicals and without the production of sludge.

"The process is purely biological, and is based on the well-known facts that sewage contains or-
ganisms which are capable of liquefying effete 591
organic solids by a process of peptonization and that under favorable conditions of temperature, added to an ample supply of oxygen, that organisms (which are non-pathogenic) are capable of indefinite multiplication, and can be so cultivated as to fulfill their life-function, which is the process of peptonization aforesaid.

"In the filter beds, the crude sewage is first concentrated, and then allowed to filter upwards 592
through a thin layer or flints, proper provision being made for rest and aeration; the organisms are thus provided with an unlimited supply of nutritive material, and at the same time their self-injurious products are being continually swept away, while the layer of flints provides them with a basis of operation, and the principle of upward filtration maintains the temperature of the bed at that of the sewers, which is, as a
rule, some ten or twelve degrees Fahrenheit 593
above that of the atmosphere.

* * * * * * *

"I am, dear sir,

Yours faithfully
G. MAXWELL LAWFORD,
Assoc. M. Inst. C. E."

(Recess.)

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"Pall Mall Gazette, June 21, 1893.

"NATURE'S SCAVENGERS.

"The Purification of Sewage by Micro-Organisms.

"It may be remembered by those who are interested in this problem that Mr. Scott-Moncrieff was able to show an excellent effluent without sludge and without the use of chemicals. In these respects he can claim that he has attained

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what has never so much as been attempted before. In all other systems, even where the aid of micro-organic life is an important factor, as in the case of the filtration experiments of the Massachusetts Board, some removal of the solid matters in suspension is looked upon as a necessary preliminary. What is being done by the
596 London County Council in their latest developments in downward filtration presupposes and includes the preliminary removal of solid matters, partly by chemical and partly by mechanical agency, while by the system we are now describing the solid organic matter is disposed of by the agency of micro-organisms alone. The theory, in brief, is that the organic matter in the raw sewage furnishes the necessary food for the micro-
597 organisms, and that the latter encroach upon the food supplies to the point of complete consumption, so that no slush remains in the filter bed after they have done their work.

"Since the appearance of our previous article, Mr. Scott-Moncrieff has established a chemical and bacteriological laboratory at Ashtead, in order to scientifically test the process which goes on in the filter bed designed by him. The labora-
598 tory work has been carried on by Mr. A. C. Houston, M. B., D. Sc., who has made bacteriology his especial study, and it has been conclusively demonstrated by him that the disappearance of the organic matters is due to the action of the micro-organisms. These organisms have been separately identified and counted, and there is no longer any reason to doubt that they are in reality 'nature's scavengers.' They are already
599 well known to bacteriologists, being classed as non-pathogenic or harmless bacteria, but it was little suspected that they could carry on the vast and beneficent work of which they are capable when cultivated under proper conditions. What chemistry and elaborate mechanism have failed to do, these organisms accomplish. By their action they peptonize the complex organic substances existing, and directly and indirectly ef-

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fect its purification. Within certain limits, which are chiefly of a mechanical nature, the concentration of the sewage is an important factor in the process, since it favors the rapid multiplication of the bacteria by furnishing them with a continuous supply of nutritive material, while at the same time their products, which would effect deleteriously their life history, are washed away. 601
Generally speaking, the rate of flow of the crude sewage regulates the multiplication of the bacteria. The time occupied in liquefying the sewage varies to some extent according to the temperature, but it is noteworthy that during the long period of frost which was experienced at the early part of the year, the temperature of the contents of the filter bed, in consequence of the vital activity of the organisms, was always 602
sufficiently high to permit the process to be carried on satisfactorily.''

"Builder, August 12, 1893.

''Mr. Moncrieff, in treating sewage, uses filter beds in which he is able to peptonize large quantities of solid organic matter. He passes the sewage through a filter composed of coke, which he has saturated with almost pure culture of peptonizing organisms, that is, organisms which 603
liquefy gelatine. By means of this biological filter, faeces, paper, and other animal and vegetable substances are rapidly broken down and brought into solution, this process corresponding almost exactly with what is taking place, though slowly, in the bed of a river, and rapidly near the surface of humid, porous, well-aerated soil or mould.

* * * * * * * * * * 604

''It is evident that the Moncrief sewage filter may be found useful in connection with the sewage farms, in reducing the whole of the solid matter into solution, and thus rendering the process of sewage manuring more regular, and, therefore, less disagreeable, especially in those instances where it is impossible to keep the solid sewage separate from the liquid."

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"*Industries and Iron,* October 6, 1893.

"*The Bacteriological Purification of Sewage.*

"The system is at work at various country houses in England, including Westbrook Hall, Sussex; Oaklands Oxshott, Surrey; Joldwyands, near Guilford; Eastwell Park, Kent, &c.; and also at the town of Towcester, in Northamptonshire,
606 where it can be seen in operation, and where the result is most satisfactory, not to say startling.

* * * * * * * * * . * * *

"We may refer those who are interested to Dr. Houston's report, which has been published by Messrs. Waterlow Bros. and Layton, Limited, London.

On the 5th of October, 1893, Mr. Moncrieff read
607 a paper before the South Midland Branch of the British Medical Association, held at Towcester, which was printed in "Industries and Iron, October 13, 1893, a copy of which I have before me, in which Mr. Moncrieff stated:

"There is no attempt at anything approaching mechanical filtration in this process. At first I applied coke, because it was supposed that the
608 interstices would afford a good nidus, or form a good place for the colonies of these organisms. Well, it was true that the interstices provided a nidus, but they also provided catch-pits for the products of the life history of these organisms. I found, therefore, that there was nothing better than the smooth surface of large flints on which the organisms could flourish, while the sewage coming in at the bottom of these gratings passes
609 through the interstices of these large flints, washes past the colonies of these organisms, and the effect is that there is an immediate liquefaction of the solid organic matter that goes on at an extremely rapid rate, and goes on apparently indefinitely. Thus after a time you get a condition of things in which there is apparently a failure of organisms to act so well from the persistance absence of oxygen and also that there

are, to a certain extent, exposed to these products of their own life history. The means to get over that difficulty are simply the duplicating of these filter beds to allow one to be at rest by a thorough process of aeration. Then these organisms throw out fresh spores, and you start de novo. There has not been any sign of clogging taking place, and even in the case of a house discharge, where 611
the faecal matter is small but comparatively solid, these organisms at once take it up and deal with it.''

Mr. Scott-Moncrieff's tank combines septic action, aeration and filtration. His American patent clearly sets forth the international use of "aerobic and anaerobic bacterial agencies for the liquefaction of solid sewage matter. 612

I will now refer to some practical installations of ordinary settling tanks and give current opinions in respect thereto. To begin with, I wish to refer to an article in the "Journal of the Society of Arts," Vol. 25, 1876, '77, page 662, a publication hereinbefore described, the said page of Volume 25 of said journal containing an account by 613
Charles Wollanstan, entitled "Hurstpierpoint (Sussex) Sewage, in which a method patented by one Mr. Leopard is described which method comprised a tank in which the sewage was strained through a straw and subsequently aerated by an exposure upon a "series of four steps or stages, each 12 feet by 60; the sewage after straining, be- 614
ing caused to flow in a thin film over each step successively, and then run direct into a brook course."

The tanks at Mevton are described by W. Santo Crimp, in his book entitled "Sewage Disposal Works; A Guide to the Construction of Works for the Prevention of the Pollution by Sewage of Rivers and Estuaries," London, Charles Griffen & Company, 1890.

The Merton sewage disposal works are described on page 151 of said book. The sewage is received into two tanks, valves admitting the use of one tank
616 only, whilst the other is being cleaned. After separation of the solids in these tanks, the clarified effluent is conveyed to intermittent downward filters.

The mode of construction of these tanks is shown upon a plate marked (Plate 12). A wall of coke is placed across each tank to filter out the grosser solids. The sewage enters the tank below the sur-
617 face, passes under a partition extending from the top down nearly to the bottom of the tank into the second compartment of the tank out of which it passes over a wall, and thence into the third compartment, out of which it flows through an opening in the bottom of the wall to the next compartment, out of which it flows over a partition wall into the
618 next compartment. This compartment is separated from the outer chamber by two walls parallel and extending the whole width of the tank at the outlet end, said walls having a series of openings through which the sewage passes to the outlet chamber. Between these walls the coke is placed, acting as a strainer. These works were built in 1878-80.

619 The tanks at Chiswick, England, are described on page 164 (with an accompanying plan) of said Santo Crimp book. These works were built in 1878. They comprise large settling tanks in which the sedimentation is assisted by chemicals, the use of floating scum boards placed mid-way in the length of the tank, and provided at the outlet with a wooden

channel built like a weir and extending out above the lower coke filters, by means of which a large amount of aeration of the effluent can be obtained, said aerating wier being designated on the plan, "wooden channel for cascade." After passing through the coke filter, the effluent goes to the river.
These works, therefore, provide for sedimentation, 621
aeration and filtration.

In 1877 Professor H. Tanner, in Vol. 49, pages 180 to 182 of the Minutes of Proceedings of the Institute of Civil Engineers, a publication hereinbefore mentioned, described the requisite elements of subsidence tanks, as understood at that time. He
said, in drawing attention to the importance of 622
constructing sewage tanks so as to facilitate the subsidence of the solid matter, that

"Tanks constructed for subsidence purposes should provide for the sewage passing through with the least possible agitation to the bulk of sewage which was there depositing its solid mat-
ter. By constructing a barrier across the tank, 623
at the same level as the overflow at the opposite end, thereby forming a small preliminary compartment, the force of the current was kept within that portion of the tank, and the passage over such barrier displaced an equal volume quietly at the overflow outlet. This might be assisted by additional barriers, some raised from the bottoms of the tanks, some pendant and sinking into
the water for a depth of from six to ten inches. 624
Tanks thus constructed at the sewage works at Barking were fully equal to three times as much work as they had previously done. By these and similar arrangements which enabled the sewage to remain tranquil whilst subsidence was proceeding, it was possible, by mechanical arrangements, to accomplish much which would otherwise devolve upon the land."

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In 1884, Santo Crimp described the "Wandle-Valley Main Drainage," in Volume 76 of the Minutes of Proceedings of the Institution of Civil Engineers, and his paper was accompanied by charts, showing a plan and elevation of the sewage tanks. The bulk of the sewage liquid is separated
626 from the solids in the tanks and then is filtered on artificially prepared filter beds. The deposited sludge is swept out of the tank, mixed wtih chemicals and pressed into manure cakes. I will quote from page 322:

"In flowing through the tanks the sewage is deprived of the floating matters by means of the
627 planks on edge at A. The deposition of the solids is aided by the cross walls, over and under which the sewage passes before finally being filtered through a bed of coke, 4 feet thick, at B, after which it passes to the filtration area for final purification. The tanks are situated in the main building; they are cleansed twice weekly, the deposited sludge being swept into the sludge pit on opening the pen-stocks. The bottom of each tank
628 slopes towards the sludge outlet, which greatly facilitates the operation of cleansing."

The plan and elevation of these tanks show the outlet to consist of a conduit or chamber, extending the whole width of the tank and having a series of openings in its walls; said series of openings or apertures extending the whole width thereof and
629 at different depths below the top and bottom, some of them being above the bottom and below the top, said outlet chamber or conduit acting as a non-disturbing outlet, and also as a strainer, coke being placed between the containing walls of said chamber for the purpose of preventing the passage out from the tank of suspended matters.

F. HERBERT SNOW. 630

In Vol. LXXIX, page 351, of the Minutes of the Proceedings of the Institution of Civil Engineers for 1885, there is an abstract of a paper by Alfred Barton Brady, entitled, "The Burnham Sewerage Works." I will quote from page 353:

"The outfall works consist of screening and filter tanks in duplicate, to allow for the removal 631
of the deposited sludge, and the cleansing or renewal of the filtering materials. * * * * * * The sewage is first received into a small intercepting chamber, fitted with two oak sluices, by means of which it is directed into either set of tanks. In flowing through the tanks, the sewage is deprived of the grosser matters by means of two rows of removable wire screens, supported on dwarf walls, and made to slide in 632
grooved piers.

"The further deposition of the solids is aided by a wier, over which the sewage flows in a thin sheet to a filter bed of sand and assorted gravel. Through this it gravitates and passes through a dwarf wall, built with 1¼-inch open vertical joints. The sewage then flows in a thin sheet over a second wier, through a second similar filter bed, and another open-jointed dwarf wall, 633
finally passing along a channel in a clarified state to the marsh dyke."

The tanks in this instance were used in conjunction with aeration and filtration. The sand was occasionally removed from the filters and washed.

The works at Friern Barnet were built in 1887. They are described in Santo-Crimps book, hereinbe- 634
fore mentioned, on page 194 thereof. The sewage is mixed with chemicals, is then conducted to three settling tanks, and after depositing the solids, passes downward and upward through coke filters and thence out of the tanks on to the artificially prepared intermittent filters. The sludge is pressed and

635

used for fertilizing soil. I will quote from page 200:

"The three settling tanks are each 97 feet long by 21 feet wide, and the depth of the sewage when flowing full varies from six feet at the inlet end to 4 feet 9 inches at the outlet end. * * * * *"

636 "The tanks are provided with scum boards and also with two cross walls, over which the sewage has to flow in a thin film. The sewage on leaving the tanks is discharged over a small wier, arranged so as to obtain as much aeration as possible."

The tanks at Wimbledon were built in 1876. A description of them is given on page 216 of Santo-
637 Crimp's book hereinbefore mentioned, and there is a plan of them designated Plate 25. The sewage passes into a chamber from whence it is directed into one or the other of the screen chambers, located on each side of the said entrance chamber. These screen chambers are provided with double bottoms upon the upper of which rest the filters or strain-
638 ers, formed of coarse hard-burned clay. In passing upward through these strainers the sewage is deprived of nearly all the solid matters in suspension. Those which settle at the bottom are periodically removed, at which time the filters are also washed out. The separation of the solids is the sole object sought to be obtained. In passing out of the chambers, the
639 sewage falls over a weir and is aerated, whence it is conducted to the sewage farm.

In my opinion, such a tank, if not cleaned out too frequently, must operate effectively as a septic filtering tank, and I find I am confirmed in this opinion by Mr. Santo-Crimp in his testimony before the "Royal Commission on Sewage Disposal," July 28, 1898, appearing in Volume 2, Evidence of the Interim Report of said Commission.

In answer to question No. 1674, on page 93, of said Report, Mr. Crimp, states:

"In the tank I place a bed of gravel, and I cause the sewage to flow upwards through that bed of gravel. In that way the mineral matters 641
themselves are deposited upon the floor of the tank, and the organic matters, the floating organic matters, such as grease and bits of excrement, and so on, that will not settle, are carried up into the body of the filter, and there they disappear; they do not come out in the end, and they do not remain in the bed of gravel, they disappear."

This is Mr. Crimp's own description of the tank 642
action at Wimbledon. The tanks at Frankfort, Germany, are described by W. H. Lindley in Volume XCVI of the Minutes of Proceedings of the Institute of Civil Engineers, 1889, page 392-3. I will quote from the latter page:

"The tanks are arranged parallel to the river, and the works will ultimately consist of two sets 643
of six tanks each, or twelve in all. The sewage enters the tanks at their eastern end, and the clarified effluent passes out at the western extremity into a channel discharging into the river.

* * * * * * * *

"The whole treatment may be subdivided into four stages. The sewage enters at its normal rate of flow into the sand-intercepting chamber, and the speed is then retarded to 1-10 of the ve- 644
locity in the main sewer. In this tank the heavier suspended impurities are deposited, and the water, after passing under scum-boards, which retain the floating matters, and through strainers which remove the more bulky matters, passes into the mixing chamber, where the requisite proportions of precipitants are added. It passes next along a conducting channel into the separate

tanks, where the velocity is further reduced to 1-100 of the original velocity. In the four tanks of the first group at present completed, the capacity has been so calculated that the sewage takes six hours to pass through them. They are 80 metres long, and 2 metres deep at the inlet end, while they gradually slope down to 3 metres deep
646 at the outlet. * * * * * * * As a rule, all the four tanks are in work at once, but the inlet channels are so furnished with sluices that any one tank at will may be stopped off for the purpose of emptying out the sludge. To effect this, the supernatant water can be drawn off at three different levels, and the sludge may then be pumped out."

I will not refer to British patents involving the
647 use of tanks.

British patent, No. 1706 was granted in 1870 to Bevan G. Sloper for Improvements in Treating Sewage. The invention relates to the favoring of the fermentatoin of sewage for the purpose of rapidly converting the nitrogenous matters into carbonate of ammonia, also the employment of chemicals to
648 precipitate the valuable ingredients in the sewage. The treatment is accomplished in tanks in which the fresh sewage is first mixed with an equal quantity of putrefied sewage already fermented and containing an abundant quantity of sewage ferment which acts very rapidly on the urea contained in the sewage and converts it into carbonate of am-
649 monia. When sufficiently decomposed, the upper half contents of the reservoir is pumped off, mixed with chemicals and led to a settling tank.

This process was an early example of the recognition of the first stages of septic action.

British patent, No. 2760 was granted in 1871 to James Brough Pow for the invention of "Improved Arrangements for Filtering and Purifying, Also for Collecting for Utilization the Solid Matters in Suspension in Sewage." By subjecting the sewage to triple treatment, first subsidence; second, use of chemicals; third, filtration, aeration and oxidation.

The apparatus consists of a series of tanks or com-
municating ascension filters, the first tank being 651
the largest, the sewage passing from it to the second tank through a vertical filter, which is disposed on the inside of the outlet end, forming a chamber with the sides tight, the sewage passing up into it through its bottom, the point of entry being below the top and above the bottom of the tank, forming
thereby a submerged non-disturbing outlet, extend- 652
ing the whole or a part of the width of the outlet end of said tank. Before entering the second tank, the sewage is thoroughly aerated by passing over a wier designed for this purpose, said wier controlling the height of the sewage in the first tank and sealing the same. The matters in solution in the
sewage passing over this weir are claimed to be 653
oxidized by three successive falls of the sewage in the form of spray. This treatment is repeated in every tank in succession.

British patent, No. 7134 to Wilhelm Gurtler, was granted in 1887 for structures formed of asphalt and metal framework in combination. It
shows a plan of a tank of this construction intend- 654
ed to be used for water closet pits, which plan shows a submerged non-disturbing inlet, consisting of a chamber within the tank, extending nearly to the bottom thereof, and a submerged non-disturbing outlet chamber at the opposite end of the tank from the inlet, said outlet chamber being located within

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the tank and having a series of apertures in its side and bottom, disposed above the bottom and below the top of the tank. The tank is hermetically sealed and provision is made for pumping out the settled solids without taking off the tank cover.

British patent, No. 3312, was granted in 1890 to
656 Walter Ernest Adeney and William Kaye Parrey, for improvements in the purification of sewage in which the sewage is kept under conditions favorable for the rapid multiplication of micro-organisms contained in the sewage, a soluble inorganic oxygen compound being added to assist the organic development and the purification of the sewage.

657 The sewage flows first to a subsidence tank where the heavier suspended particles are deposited, thence the effluent flows to a second tank containing horizontal filters or strainers which remove the lighter suspended particles.

This preliminary treated effluent may be further treated in three ways:

658 First: By being neutralized, if necessary, and mixed with an oxidizing compound and thence conducted to a subsidence and incubation tank, the contents of which are maintained throughout the year at such a temperature as insures the greatest development and multiplication of the micro-organism. This incubation tank being large enough
659 so that the effluent entering it becomes diffused into the contents thereof and remains in it some time before flowing away to the filter tank.

Second: By being first thoroughly aerated in a form of spray and then mixed with oxygen compounds and conducted to the subsidence and incubation tank, as above described.

 660

Third: The same as the second way, excluding the use of all chemicals.

The effluent from the subsidence and incubation tank flows into the last tank of the system, being a horizontal filter, the effluent of which is suitable to go into a river.

This patent clearly describes in the third method, 661
especially, the intentional use of the natural liquefying bacterial process in combination with aeration and filtration. The patent states:

"The liquors may be filtered and aerated at any of the stages of the process."

And it gives the period in which the sewage
should remain in the subsidence and incubation 662
tank as from two to twenty-four hours, according to the nature of the sewage to be treated. In the first two ways of treatment comprising the use of chemicals, the object is to promote the activities of those liquefying organisms of the aerobic kind; but in the third way, in which chemicals are excluded,
the destruction of organic matter in the said sub- 663
sidence and incubation chamber could only be through the agency of what is now called the more distinctly anaerobic species. Clearly, in this case, the tank would be what is now called a "septic tank."

British patent, No. 22747, granted in 1891 to
Joseph Tertius Wood, for Improved Methods of 664
Purifying Sewage, accomplished by introducing air into the sewage in such a manner as to split up or finely divide the solid particles so the sewage may dissolve a sufficient quantity of oxygen to effect purification. The invention provides, first, for the settling of the solids by means of chemicals and

tanks; and, second, the purifying of the matters in solution by various means of oxidation. In the first case, a tank is used in which the chemicals and sewage are mixed by the aid of a blast of air. From this tank the sewage passes to large settling tanks in duplicate, where a period of quiescence is obtain-
666 ed. In the second stage, purification is accomplished by soil filtration, or irrigation of crops, or introduction of air into the sewage in various ways. Claim 2, of the patent, reads as follows:

"The construction substantially as herein described in reference to figures 1 and 2, whereby the sewage is first subjected to the oxidizing and deodorizing process and to precipitation during
667 a period of quiescence, then to pass on to the oxidizing stairs and again subjected to a secondary oxidating process."

British patent, No. 8671 was granted in 1894, to Frank Pullen Candy, for Improvements in Upward Flow Precipitation Tanks and Filters for the Purification of Sewage, consisting first of causing the
668 sewage to enter from the side of the tank at one or more points at the required depth, in such a manner whereby the flow of the sewage is equalized and divided over the whole of the tank as much as possible; second, of spreading and equalizing the flow of sewage upon the top of aerating filters, in constradistinction to "water-logged filters," by show-
669 ering the sewage from overflowing conduits upon spreaders placed upon the surface of the bed, or by perforated pipes placed on the surface of the bed and pivoted in the center thereof and made to revolve horizontally, or by traveling perforated pipe or other suitable means of showering the filters.

The tanks are provided with an inlet chamber

located on the outside of the tanks and connecting with the inside by a series of pipes entering the tanks below the top and above the bottom. The outlet chamber is situated on the outside of the tank connecting therewith by a series of pipes or openings through the wall of the tank and at the
top thereof. 671

I will now refer in chronological order to several United States patents.

Adjourned to Tuesday, June 13th, 1905, 10:30 A. M.

New York, June 13th, 1905, 10:30 A. M.

Met pursuant to adjournment.

Present, Counsel, as before. 672

Direct Examination of Mr. Snow Continued:

(Witness continues his answer to Q. 26).

United States patent, No. 138, 250, April 29,
1870, to Fritz Hille, for treating sewage by a system
of depositing tanks, the claim of the patent being
for a combination of the deposit tank and filter, and
self-acting floating outlet to draw off the liquid at 673
or near the surface of the tank. Also the combina-
tion of an agitating chamber with two sets of de-
posit tanks and filters, so that one series may be
cleaned without the necessity of stopping the flow
of sewage. The tanks are divided by a transverse
partition into three compartments so as to impede
and obstruct the flow of the sewage and allow the 674
almost complete settlement of the solid matters held
in suspension. The final purification of the sewage
is effected on artificial downward filters.

United States patent, No. 108,664, October 25, 1870, to George William Wigner, is for sewage disposal apparatus in which the sewage or other

liquid coming through the sewer is delivered into a
well where grit and other solid matters are allowed
to settle. It then passes through pipes into the set-
tling tank or tanks, through a culvert, having open-
ings in the brickwork, which openings are below
the surface of the sewage in the tank, and extend
676 across the entire end of the tank, forming a non-
disturbing inflow into the tank. The bottom of the
tanks slope to mud channels where the sediment is
passed into other channels leading to a pit. There
are two sets of tanks, each having three compart-
ments. As the sewage flows from one compartment
to another, it passes over a transverse partition
677 wall. The effluent leaves the tank over a wier,
where it is aerated naturally, falling into a collect-
ing culvert from which it is delivered by a wier to
the filter. The tanks are arched over, operated on
the continuous principle, and provided with a non-
disturbing inflow and outflow and combine sedimen-
tation, aeration and filtration. The first claim of
678 the patent is for the use of a catch pit. The fourth
claim is for tanks having sloping bottoms and mud
channels for collecting the precipitated sediment.

United States patent, No. 184, 099, November 7,
1876, to George R. Moore, for an improvement in
odorless closets, provides for an improved recep-
tacle or vault for sewage. It provides a non-dis-
679 turbing inflow B below the surface of the liquid in
the vault and a non-disturbing outflow, E. This
tank would operate as a septic tank. It is her-
metically sealed, the inflow and outflow being below
the surface of the water, for the purpose of prevent-
ing the escape of gases and retaining all floating
matter. While designed for the individual house,

 680

the patent states that while the pipe, B, connecting the closet with the vault, is shown in the sketch as straight and vertical,

"Any shape, direction, or distance is practicable as long as the privy-seat is high enough to afford a descent to the vault; also, any number of pipes from other seats may be conducted either directly to the vault or indirectly by branching into B." 681

"E is division-plate or kind of strainer, to keep floating paper or other like materials from obstructing the passage of fluid matter out through the cock F."

United States patent, No. 258,744, to Amasa S. Glover, May 30, 1882, for apparatus for the disposal of sewage, comprises a combination of tanks 682
covered over and ventilated. The sewage is discharged into the first of a series of tanks, F, from which it overflows into the succeeding tank, depositing in each a portion of the suspended matter, until it is comparatively free from such matter, and passes out of the last tank over a wier, over which the sewage flows in a thin film and is aerated. The 683
gases being conducted to the chimney. The express object of the invention is to prevent contamination of the air by gases and odors.

I was very intimately acquainted with Mr. Glover from the date of this patent to his death, in 1897, and I know from conversations with him that the idea for this patent was obtained from the cess- 684
pools located in the yard of his residence on School Street, in Brockton, Mass. I had my attention called to these tanks in 1882. I have drawn a sketch which I have entitled, "Sketch of Glover's Cesspool, drawn by F. Herbert Snow." I made this sketch from my recollection of the tanks, as they

685 F. HERBERT SNOW.

were when I examined them during the eighties. The first tank was provided with a submerged non-disturbing inlet, marked A, and a submerged non-disturbing outlet, marked B; also a ventilation pipe. From this apparatus, Mr. Glover conceived the idea of a series of cess-pools covered over and
686 ventilated into one chimney, which idea took the form of the apparatus embodied in the above patent. Mr. Glover knew that solid matters disappeared in his cess-pool, and I have known him to claim that a similar action would be accomplished by his 1882 patent.

United States patent, No. 280,545, July 3rd,
687 1883, to Silas Wilcox for a grease trap, comprises a tank divided at one end, the outlet end, by a vertical partition, *c*.

"that forms a small compartment, *d*, which is closed at the top, and communicates with the main part of the box by a slit or space at the bottom of the partition *c*."

The compartment, *d* comprises an outlet cham-
688 ber or conduit, located in the tank, A, and extending the whole width thereof, connecting with the tank by a slot or opening in the side of the chamber, said opening extending the whole width of the tank and acting as a submerged non-disturbing outlet.

United States patent, 315,912, April 14, 1885, to Robert Corscaden, for collecting and drying sedi-
689 mentary matter of sewage, provides for the use of two or more deep catch basins for the collection and removal of the sediment of sewage. There is a float placed at the outlet opening of the catch basins and adapted to prevent substances in suspension from passing off with the overflow.

Recess.

F. HERBERT SNOW. 690

United States patent, 366,333, July 12, 1887, to Albert T. Marble and George W. Knapp, for a purifying and aerating plant for the filtration and treatment of sewage, provides for large settling tanks, A1, from out of the bottom of which the sewage is conducted to an outlet chamber, A2, connecting
with a wier chamber in which there are strainers, 691
up through which the sewage flows and thence over the wier, S. The sewage flows in a thin film and continues thus down a succession of steps and is aerated. The function of the settling tank is plain subsidence, operated on a continuous principle.

United States patent, No. 367,576, August 2nd, 692
1887, to George A. Allen, for an improved water cistern, the improvement being adapted to reservoirs of any size—to insure a discharge of water from a level below the surface thereof and above the bottom of the tank to avoid the passage of either surface scum, impurities, or sedimentary deposits, into the discharge pipe. The outlet thereof consists
of a floating conduit or compartment having a 693
series of slots or openings in its walls, *h*, these openings delivering the water from the tank into the said chamber and thence through the outlet pipe G. The float I, attached to the outlet chamber G, keeps the said chamber in suspension, and hence assures the position of the slots or openings *h* always being
a certain distance below the surface of the water in 694
the tank.

The reservoir may be either square, rectangular, oval or other shape, and of any size, and the floating outlet conduit and the discharge pipe would therefore be aranged in size, &c., to meet all requirements.

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United States patent, No. 368,079, August 9, 1887, to Loring Coes, is for an apparatus whereby sewage is separated into spray or finely divided particles within the chamber of a chimney or stack by a forced current of air. The patent states:

"I am aware that heretofore air has been forced
696 through water and sewage for the purpose of
aeration and purification, and I do not, therefore,
herein bodily claim the use of air blasts for such
purpose. My invention refers to the method
whereby the purification is effected in connection
with a chimney or stack."

The invention provides for the use of a tank or
conduit through which the sewage is always flow-
697 ing, along the greater length of which there are
placed revolving screens for the interseption of
suspended matters, and at the outlet end of which is
the aerating chamber in the base of the stack. The
process is purely mechanical, the tank serving the
office of a conveyer of flowing sewage.

United States patent, No. 403,946, May 28, 1889,
698 to Oluf E. Meyer and Charles H. Weck, for appa-
ratus for treating sewage, provides for the use of
plain subsidence tanks in pairs, with an inlet at the
top, a submerged outlet above the bottom, said out-
let containing screens and strainers and discharg-
ing into a secondary settling tank, out of which the
sewage flows through a submerged horizontal filter,
699 said filter being situated at the bottom of the tank.

United States patent, No. 424,838, April 1, 1890, to Frank L. Union, for an improved cess-pool for the complete separation of the solid and semi-solid portions of the sewage from the liquid, retaining the former in the receiving pool and delivering the latter to the discharging pool, provides for a sub-

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merged non-disturbing inlet *f* into the first compartment, in which the solids are intentionally retained. A dividing wall separates the inlet from the outlet compartment, the top of said wall *c* being below the surface of the sewage. The outlet *g* from the tank is submerged and non-disturbing. The reservoir is arched over and made air-tight. In op- 701
eration, the heavy solid matters will settle in the first compartment, the water flowing over the partition into the next compartment, from whence it will be taken by the outlet pipe and conveyed to a second reservoir which thus receives only the liquids. The sides of this second reservoir, *b*, may be porous. 702

A good many of these tanks have been built in the vicinity of Boston, Mass. This tank system was installed at the Danvers State Lunatic Hospital. The same tank system is now in use at the end of the main sewer at Milford, Mass. It is operated on the septic principle.

United States patent, No. 478,654, July 12, 1892, 703
to Elmer F. St. John, for an improved catch basin for grease and sewage, provides for an inlet and outlet submerged. The inlet pipe, H, passes into the basin and extends down, projecting below the water line, so the water will enter quietly beneath the water already in said basin so as not to disturb the grease on top of the water, as in the old style 704
basin, thereby allowing the water to flow out of the basin without sediment or grease.

The outlet pipe is connected with the bottom of the basin and extends up on the outside of it to a point as high as the water line of the basin, thus trapping the basin. The bottom of the basin is pro-

705

vided with a discharge opening by which the basin is cleaned out. This pipe is usually closed by a plug.

This device or apparatus is simple. Defendant's plant is similar in these respects, that each tank is
a large grease trap, having a submerged inlet and a
706 submerged outlet, the object of the tank being to remove the solids from the liquids, and to discharge the liquid into an outlet pipe from the tank, minus such matter.

The novelty of this patent consists of the cylindrical adjustable sections comprising the basin.

United States patent, No. 484,823, October 25,
707 1892, to Ernest Edgar Scruby, for apparatus for purifying sewage effluents, shows in the drawing, a tank, B, connected by pipe, C, to an aerating chamber, which chamber is airtight, into the upper part of which the sewage is led by the pipe, C, and then showered or broken up into spray as much as possible by means of a showering plate which may be
708 coned or semi-spherical, or of other suitable form. Below this sprayer, D, is fixed a perforated basin. E, bowl-shaped, for further showering the liquid and intercepting any solids. An oxygen main with necessary branch blow pipes, with suitable nozzles, is placed between the showering plate, D, and the basin, E.

709 United States patent, No. 505,166, September 19, 1893, to Oluf E. Meyer for sewage apparatus, comprises a series of tanks, containing division walls, baffle boards and a submerged outlet, combined with filters and aeration. The conduit through which the sewage is admitted to the settling tank is divided into two or more branches, which lead in-

to a corresponding number of separate settling
tanks. A gate is provided at the junction of the
branches whereby either branch may be closed and
the sewage turned into the other. The discharging
ends of the branches are expanded laterally so as
to spread the sewage and check its flow as it en-
ters settling tank. Each of these tanks is prefer- 711
ably divided into three or more compartments by
partitions extending from the bottom thereof up-
ward to about the level at which it is designed to
maintain the sewage therein.

Between and parallel with the said partition,
each tank is provided with a partition, *b2*, project-
ing at its lower and below the upper edges of the 712
other partitions, and extending therefrom upward-
ly a sufficient distance to catch and retain greasy
scum and light refuse floating on the surface of the
sewage. These tanks are provided with a close cov-
ering, having openings and doors to afford access
thereto, for the purpose of removing the sludge
therefrom. 713

At the ends opposite the inlet there is an outlet
conduit, extending the width of the tank, but rap-
idly converging as it extends away from the tank
and uniting with the outlet of the other series of
tanks in one common conduit, leading to the filter.
The opening, *c*, into this outlet conduit is located
below the level of the sewage in the tank so as to 714
prevent any greasy scum or like refuse which may
pass the partitions in the tank from passing out of
the same. The outlet from these tanks is therefore
a submerged conduit the entire width of the tank
having a slot or aperture, extending the whole of
said width, said slot or aperture being above the

bottom of the tank and below the level of the sewage in the tank.

The effluent from these tanks is conducted to a filter where it is thoroughly aerated and passed through the filter and purified.

United States patent, No. 530,662, December 11,
716 1894, to W. D. Scott-Moncrieff, for the treatment of sewage and apparatus therefor, has for its object to purify sewage and discharge a clear, inoffensive effluent, which is accomplished by the action of microbes which liquefy and break up the organic matter in the sewage. I will quote from the patent:

"Hitherto it has been believed that the bene-
717 ficient action of these organisms in the purification of efete matter could only be carried out in the presence of oxygen, and with this aim in view experiments have been carried out almost exclusively in the direction of downward filtration, the object being to secure the largest amount of oxygen available by atmospheric contact during the operation. One obvious objection to this process is the necessity for preliminary straining or
718 deposition of the coarser particles of the sewage to prevent clogging the filter. This straining or deposition, as a matter of fact, amounts to nothing more nor less than depriving the organisms of the greater proportion of their food supply, leaving a mass of filth which never enters the filter and consequently is never broken up or nitrified, and so constitutes a nuisance in itself. I have discovered that the total solid matter in
719 ordinary sewage can be dealt with as the actual food supply of the organisms if it is properly conveyed to them. All that is required for this purpose is to concentrate the sewage in a comparatively small space, and to have a constant movement occurring. When this is done, there is no need for the same amount of oxygen as has hitherto been believed to be necessary.

"It is also an essential part of the process that

the enzymes of the saprophytic species which
perform the work should be removed as soon as
formed from that portion of the filter bed where-
in it is believed that the production of micro-or-
ganisms is most active.

"The following, among others, are the organ-
isms which it is the especial object of the ap-
paratus to cultivate, namely: bacillus, flour- 721
rescens, liquefaciens, bacillus subtilis, protean
forms (particularly the proteus vulgaris), bacil-
lus figurans, &c.

"According to my invention, no preliminary
straining of the sewage is necessary, the ap-
paratus being so arranged that the bacteria mul-
tiply and increasingly perform their functions.
Any previous removal of organic matter from or-
dinary sewage being detrimental to their action. 722

"My invention comprises also special means
for maintaining them healthy and vigorous. I
also provide means for the further purification of
the effluent obtained from the cultivation of the
filtering bed. The apparatus I employ includes
a tank, the lower part of which is below the level
of the intake pipe (also filtering material carried
upon a perforated diaphragm), beneath which
there is a space or chamber, into which the crude
sewage is led by a suitable pipe E, the superficial 723
area of said chamber D being considerably less
than the full base of the tank A. Provision is
also made for the removal of inorganic detritus
by means of suitable valves H. The apparatus
is such that by simple adaptation of its dimen-
sions it is capable of dealing with any required
volume of sewage, and is therefore applicable
equally to public and private sanitation. 724

"My invention includes also means for insur-
ing the most favorable conditions in the filtering
material for the development of the micro-organ-
isms contained in the sewage. Suitable inlet, out-
let, flushing, and cleaning appliances are pro-
vided, and my invention includes also special
means of resting and aerating the filtering ma-
terial without interfering with the continuity of
the treatment."

725

This invention provides for the treatment of sewage by what is now called septic action, combined with filtration and aeration.

United States patent, No. 556,596, March 17, 1896, to Frank L. Union for the aeration and filtration of sewage after the solids and semi-solids have
726 been separated therefrom, provides for a tight filter bed tank with the bottom thereof sloping uniformly to one end where the effluent is siphoned off by a number of pipes. The sewage is delivered on to the surface of the filter tank to a series of parallel pipes or troughs, the object being to distribute the sewage evenly over the surface of the beds, thereby
727 aerating the sewage and filtering it after the solids and semi-solids have been separated from the sewage. This therefore combines aeration and filtration with any previous treatment of sewage for the removal of solids therefrom.

I will now refer to the use of ordinary tanks in the United States.

728 Adjourned to Wednesday, June 14, 1905, 10:30 A. M.

New York, June 14th, 1905, 10.30 A. M.

Met pursuant to adjournment.

Present, counsel as before.

(Examination of Mr. Snow Continued.)

729 (Witness continues his answer to Q. 26.)

I find that Waring, in his book entitled "The Sanitary Drainage of Houses and Towns, published in 1876, says that at Newport, Rhode Island, he had used a cemented brick grease trap four feet in diameter, and he shows a sketch of it which I have made and herewith present.

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I understand from this published account that
the tank was built absolutely water-tight and
worked on a continuous principle, with a vent,
submerged outlet pipe, at least one foot below
the surface of the grease, and that there was am-
ple opportunity for any solid matter to collect at
the bottom below the outlet, and that it was found 731
unnecessary to clean out this particular trap or
tank more often than once a year, and that the
explanation of this in Mr. Waring's own words
was:

"The solid deposit being organic matter de-
composes in the form of ammonia which helps to
dissolve the grease and make it soluble, so that 732
both the deposit and the scum are constantly be-
ing washed away."

This was septic action.

It is noteworthy that Mr. Waring at that time
considered and so stated that no form of grease
vat or tight cesspool could serve for the final
disposal of house slops, he taking the stand that 733
it was only an intermediate step in the process
whose further course it was very important to
direct, and I further understand that he con-
structed a tight cesspool working on the con-
tinuous principle with the entering pipe near its
top, the cesspool being arched over and closed by
a cap and thoroughly ventilated, with the outlet 734
pipe starting from a point one foot below the sur-
face of the water and connecting with open-
jointed tile drains laid a few inches below the
ground and operated intermittently, the advan-
tage of the intermittent action being that the tank
fills the ground with sewage for a short time in

the immediate vicinity of the pipes, and then as the liquid subsides fresh air enters the soil and assists by its oxidizing action in the work of purification. At that time Mr. Waring said in his book:

"Whether the irrigation be on the surface or
736 by means of underground pipes, the copious intermittent discharge is in every way preferable to the steady small flow."

I have before me a copy of a book entitled "Sewerage and Land-Drainage," by George E. Waring, Jr., 3rd edition, New York, D. Van Nostrand Company. London, E. & F. N. Spon, 1891.

737 On page 287 of this book there is an article on "The Disposal of House Wastes." I will quote from this article:

"All competent authorities are in full accord as to the pernicious character and absolute inadmissibility of cesspools, or of any form of receptacle * * * * * * * * * * * which are not subject to constant or frequent renewal.

738 "Wherever there is a considerable amount of land available, not too near occupied buildings, the safest and best means of disposal is by surface-irrigation, * * * * * * Where this means is adopted it is important to collect the sewage in a vessel from which it may be intermittently discharged in volume sufficient to cover a considerable area of land. The ordinary set-
739 tling basin and flush-tank, described below, accomplish this purpose in a satisfactory manner.

"Where less land is available, or where for any reason the discharge of the sewage over the surface of the ground is objectionable, a perfectly good result may be obtained by the use of what is known as the sub-surface irrigation system. The essential element of this system is a line or lines of ordinary agricultural drain-tile

 740

properly laid near to the surface of the ground and having uncemented and rather wide joints between their ends. * * * * * * * * * It is as important in this case as in the other that the sewage should be accumulated in a proper vessel until the volume is sufficient to fill the whole or a large part of the series of drains, and especially to prevent a constant flow, which 741
would give no intermission for aeration.

(On page 288.)

"A few years later Mr. Rogers Field made use of the same system * * * * * * supplementing the drains with a flush-tank arranged to hold back the flow until it became full, and then to discharge it with one rush into the tiles, affecting thereby a long period of intermission, during which the soil was exposed to aeration 742
and consequent purification, * * * * * * * * *

"In this form the apparatus was somewhat extensively used in England and elsewhere. At my own house in Newport, * * * * * * I interposed a settling basin * * * * * * in the course of the drain leading from the flush tank to the absorption area. This held back coarse matters and a large proportion of the 743
grease. There was, however, always some difficulty resulting from the adhesion of grease to the outlet of the flush tank requiring frequent cleaning of the siphon, and, later such a disturbance of the accumulated matters in the settling basin as caused fluent and greasy particles to flow forward and in time choke the drains.

"The next improvement was to place the settling basin between the flush tank and the house, 744
serving as a grease trap, protecting the siphon of the flush tank against the gradual accretion of grease, and leaving only a relatively clear liquid to be discharged into the pipes. This was a great improvement, and practically effected all that was necessary where only the small flow of the kitchen-sink was to be taken care of. It was found, however, when it became a question

of disposing of the entire waste of a house, including water-closets, baths, &c., that the flow into the settling basin had at times sufficient force so to disturb its deposits as to cause a considerable amount of semi-solid matter to pass over into the flush tank, leading in time to the obstruction of the drains. This has been reme-
746 died by constructing in the settling basin, a division wall at right-angles to the line of flow, and built to about the height of the ordinary water level. This wall, dividing the basin into two chambers, confines the disturbance caused by the inflow to the first chamber. The flow from this into the other chamber, being in a thin stream over the top of the wall, does not disturb the deposits, and only the liquid passes into the flush
747 tank.

* * * * * * * *

"It is, in fact, a perfect system for the disposal of liquid household waste, practically and theoretically, with a single limitation—viz.: it still involves the retention of a cesspool of inconsiderable size. It is impracticable to allow the discharge of kitchen and water-closet matter, including paper, to flow directly into the flush tank; it would soon obstruct the siphon, and so
748 much of it as passed on into the drains would soon obstruct these. It is imperative that such matters should be withheld until by maceration or by decomposition they will pass on in solution or in suspension in the liquid flow. Insofar as decomposition is necessary, the settling basin is, in a less degree, subject to the theoretical objections that are made to the cesspool It is, how-
749 ever, to be considered that this settling basin, which is perfectly tight as to its walls, is so small that the volume of water passing through it takes up the products of decomposition, and carries them on to the drains before they assume a condition at all comparable to that of the permanent cesspool. It is found, practically, that the arrangement is inoffensive and safe.

* * * * * * * *

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"It may be worth while to say a further word concerning the atmosphere of the settling chamber, which is, in a certain sense, a permanent cesspool. This air cannot fail to be made foul by the decomposition of the sewage there retained, but the frequent renewal of the small volume of sewage reduces this difficulty to the minimum. It is desirable to remove the deposits of 751
the settling chamber from time to time—as observation may show to be necessary. No rule can be fixed as to this. In some cases the decomposition is so complete that the chamber never accumulates much deposit. In others it should be cleaned out monthly. The proper relation between size of chamber, amount of water discharge, and proportion of foreign matter in the water, can not be fixed in the present state of ex- 752
perience with the apparatus."

On page 291 is given a plan and section of the settling tank and flush tank which shows a submerged inlet and outlet to the settling chamber. I will quote from page 292:

"I introduced this system for the disposal of the entire sewage of the village of Lenox, Mass., about 1876. * * * * * * * * * I con- 753
structed the same system for the disposal of sewage at the Women's Prison at Sherborn, Mass., in 1879. * * * * * * * * * The same system constructed for the disposal of the sewage of the hotel at Bryn Mawr, Pa., was entirely successful from the date of its construction in 1881 until the hotel was burned, five or six years later. I should not hesitate to adopt this sys-
tem wherever needed for an institution or even 754
a village of considerable size. At the same time, my confidence in the efficiency and inoffensiveness of surface-irrigation disposal is now so great that I should prefer it wherever the circumstances were suitable."

I have before me a catalogue entitled "Flush Tank Company, Chicago, Manufacturers of Au-

755 tomatic Siphons for Intermittent Flush Tanks,"
169 La Salle Street, Chicago, Ill., 1892. On page
24 there is a diagram of an intercepting chamber
and flush tank, the inlet and outlet to the said
chamber being submerged. I will quote from
page 24:

756 "For a number of years past sub-surface irrigation—the disposal of foul liquids by open-jointed drain tiles laid near the surface of the ground within reach of the roots of vegetation—has to a considerable extent taken the place of the pernicious cesspool for the disposal of the sewage of isolated houses, and even for a cluster of houses and small villages.

757 "This method, when combined with an intermittent discharge of the sewage into the tiles by flush-tanks, is not only a very great improvement on the cesspool, but it is probably as nearly perfect as the conditions of the case will allow. * * * * * * * * * * The best form of flush tank and intercepting basin is also illustrated by cut No. 1.

"The sewage is allowed to flow into the inter-
758 cepting chamber, where the solid matter is held,
until by decomposition it is so thoroughly mac-
erated that it will pass off in solution or, in the
form of small particles, in suspension with the
liquid. It has been found that unless the par-
tition wall in the intercepting chamber is used,
the disturbing effect of the inflow from the sewer
is sufficient to cause considerable semi-solid mat-
ter to reach the flush tank, and hence the drains.
759 This wall confines the disturbance to the first
part of the chamber. The flow over the wall be-
ing in a thin stream does not seriously disturb
the deposits, and only what is mainly liquid
passes into the flush tank. * * * * * *
"It is practically and theoretically a perfect system of disposing of household wastes, except that it involves the retention of a cesspool of limited size, which the intercepting chamber amounts to

in effect. By ventilation the air of this chamber is far less foul than that of the ordinary cesspool, and as it is water-tight the unpurified sewage is not allowed to find its way into the subsoil. Deposits should occasionally be removed from this chamber, though in some cases the decomposition is so complete that it does not accumulate much deposit.'' 761

This describes septic action combined with aeration and filtration. The intercepting chamber with its submerged inlet and outlet corresponds to the septic tank of defendant's plant. The flush tank, with its ventilation and aeration, corresponds to the flush tank of defendant's plant, which tank also contains an aerating de- 762
vice, but of specific design. The filtration may be either surface or sub-soil in character. In defendant's plant surface filtration is used.

On page 26 of said catalogue there is a cut showing the system applied to ''intermittent surface irrigation.'' I will quote from this page:

''If the main discharge pipe be carried to the surface, the sewage may be allowed to spread 763
over the ground without offense or injury * *
* * * * * *

''This company owns patents covering not only the various forms of flush tanks used for intermittent sub-surface and surface irrigation, as described, but it also owns the patents of Col. George E. Waring, Jr., covering the use of a grease trap or intercepting chamber between the 764
flush tank and the house, to hold back the solid matter until dissolved or macerated; and the use of a dividing wall in the intercepting chamber, allowing the liquid to flow in a thin sheet over its top for the purpose of more fully detaining the solid matter until sufficiently macerated.''

On page 216 of Mr. Waring's book on ''Modern Methods of Sewage Disposal,'' published in 1894,

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he calls attention in respect to his double chambered flush tank arrangement for the disposal of the sewage of isolated houses, and states that the first chamber holds the solid matters and scum and thereby has some of the worst characteristics of a cesspool, for while the free movement of
766 liquid through it prevents a high degree of foul putrefaction of any kind of its liquid portion, and indeed carries off the gases or the putrefying sediment, the scum with which the contents of the tank are always covered is in a constant state of decomposition, and is consequently producing foul and objectionable vapors. Mr. Waring says
767 in reference to this:

"No way has yet been discovered in which this foul deposit chamber can be dispensed with, in the case of sub-surface disposal, with the absorption drain generally used."

On page 218 of this same book, in speaking of the action in the settling chamber, Mr. Waring used these significant words:

768 "Under some circumstances, perhaps due to a higher temperature in the sewage, and this to a larger amount, the decomposition of the sediment and of the scum is sufficiently active to prevent accumulation to an injurious amount. In such cases, the settling chamber may never be cleaned. This is not to be depended upon without occasional inspection. In the majority of
769 cases, it is necessary every few months to bale out the chamber and get rid of its accumulation, which should be buried or dug into the ground at once." This is a description of septic action.

Mr. Waring, who was afterwards Street Commissioner of New York City, and is now dead, was an eminent authority in matters pertaining to sanitary engineering. In his 1876 book, re-

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ferred to from pages 315 to 320 he referred to Bailey-Denton's Downward Filtration Plant at Merthyr Tydvil in Wales, and also to the Denton and Field Flush Tank Apparatus to be used "in agricultural irrigation of the sewage of small communities where the constant stream
is too slight to secure the flooding of a sufficient 771
area for an economical use and for intermittent application to successive fields."

British Patent No. 742, granted in 1872 to John Bailey Denton and Rogers Field for this apparatus, comprises another use of sewage tanks not hereinbefore specially mentioned by
me. This principle is brought into use in de- 772
fendant's plant at Saratoga.

The Waring tanks were septic tanks. The solvent action of putrefaction was known and intentionally utilized. It was not called septic action then, but this term is now applied to it. I was acquainted with Mr. Waring and in the latter
eighties he observed in my presence that the 773
solvent action and decomposition agencies in his tank were of a bacterial character. He spoke of Pasteur and the application of Pasteur's theories to the art of sewage purification as practiced in Berlin and in France, England and America. Most especially did he commend his tanks and
filtration system. He was an apostle of fresh 774
sewage treatment and deprecated the necessity of the putrefactive chamber in his system. He recommended at that time for the City of Brockton the disposal of the sewage, solids and all, upon the surface of the ground in as fresh a condition as possible.

775

A few years after Waring's first book above
referred to was published, Mr. Edward S. Phil-
brick, C. E., another high authority upon these
subjects and who is also dead, published in the
"Sanitary Engineer" of May 10, and May 17,
1883, the same being published in New York
776 City, a serial article describing the system of
sewage disposal by an apparatus of his own de-
sign. My understanding of the drawings in
these articles, assisted by the description there-
in is, that they show, first, a tank cesspool work-
ing continuously upon the septic principle, that
is, with a submerged inlet and outlet pipe, and
777 flowing into, second, a collecting chamber; third,
a siphon in a separate chamber which automati-
cally empties the collecting chamber periodically
when it becomes full. The interposition of this
collecting tank or chamber prevented the con-
tents of the septic cesspool being disturbed by
the action of the siphon, and thus prevented the
778 contents of the septic cesspool being disturbed.
The sewage is discharged from the collecting
chamber into the pipe a few inches under the sur-
face of the ground, this discharge being intermit-
tent.

Recess.

779 Philbrick's collecting tank and automatic siphon thus connected the constantly flowing and active putrefaction or septic tank with the disposal pipe and soil, so as to give to the latter the intermittent doses required for their proper action. I will quote from the article as follows:

"If house sewage is allowed to flow directly into

a system of porous tiles laid under the surface, the fluid parts escape at every point and soak into the soil; but the solid matter which may not have become finely divided is apt to linger in the pipes and soon fill them up so that they become practically useless until taken up and cleaned. In order to avoid this result, it has been found necessary to
provide a tank or tank cesspool in which the solid 781
particles of the sewage may become macerated and finely divided by fermentation before entering the distributing pipes. * * * * * * * * * If this siphon were to be applied directly as an outlet for the tank which receives the sewage from the house it will soon get choked by the scum which collects on the surface or by the sediment which collects on the bottom. It is therefore found best
to construct a second tank between the first, which 782
I call the settling basin on the plan, and the siphon itself. * * * * * * * This settling tank being always full of the putrefying mass, should be made perfectly tight, and should be ventilated by an air hole as shown. This vent should be extended to a suitable place on the roof of the barn or stable or house, or upon a large tree where its gases will not give offense."

He further says: 783

"That the connection between the settling tank and the flush tank should be by iron pipes built into the walls as shown, so that the air can pass freely from one tank to the other at all times, and so that the overflow of the settling tank may not be from the surface or scum, nor from the bottom, but from a point about a foot below the surface."

I have made a copy of the drawings in said ar- 784
ticle entitled "Siphon Tank." The Sanitary Engineer, page 554, May 17, 1883, which I now present.

Mr. Philbrick gives in the same article a sketch of the apparatus as applied to the drainage of the Bryn Mawr Hotel near Philadelphia.

785

This apparatus of Philbrick's was an international regulation and provision for the septic process of sewage disposal combined with aeration and filtration, and many of these tanks, or modifications of them, were constructed at various places in the Eastern states. Defendant's
786 plant at Saratoga is one of them.

In the book entitled "Sewage Disposal in the United States," by George W. Rafter, M. AM. Soc. C. E., and M. N. Baker Ph. B., New Yor, D. Van Nostrand & Company; London, Sampson, Low, Marston & Company, Limited, 1894, the same having been copyrighted 1893, and the first
787 edition published in January, 1894, on page 456, there is a chapter devoted to "Broad Irrigation at the Worcester, Massachusetts, State Hospital for the Insane," illustrated by sketches, said to be the first successful irrigation works in this country, having been designed in 1876, and previously described in the 47th Annual Report of
788 the Trustees of said Institution, for the year ending September 30, 1879. I will quote from page 458 of Rafter & Baker:

"The settling tank Fig. 69, is 30 feet long, 16 feet wide, and covered by arches turned upon iron girders, with side walls and bottom of brick laid in cement, and made water tight by a Portland
789 Cement plaster coating one-half inch in thickness. The sewage enters the tank at the west end and flows out at the east end, as indicated on the plan. About two-thirds of the distance from the inlet to the outlet a brick partition is built across the tank, in which are placed 4 plates of brass perforated with 60 holes one-fourth of an inch in diameter. The lower plates are 30 inches from the floor of the tank; the entire partition is 4.5 feet high, and

capped with a strong netting of galvanized wire of ½-inch mesh. As stated, the sewage is received into the larger division, while the solids are detained, the fluid portion straining through the brass plates and wire netting and passing to the main sewer to be used for irrigation.

"The published reports do not furnish any detail as to just the method used for disposing of the 791
sludge from the settling tank and the frequency with which the tank is cleansed. Definite statements are also lacking in regard to the quantity of sewage per day, quality of the soil of the irrigation area, etc."

From this description and the accompanying plans I understand this tank to be a septic tank used in combination with aeration and filtration 792
in natural soil. The tank contains the elements of defendant's plant. In both there is a submerged inlet and a submerged outlet. In both there is an outlet chamber connecting with the main tank by a series of openings in the dividing wall, said openings being below the top and above the bottom of the tank and extending the 793
whole, or nearly the whole, length of the wall, or width of the tank. In defendant's plant there are 96 holes in the said wall. In the Worcester plant there are 60 such holes in the wall, said wall comprising a brass plate. In both plants the effluent from the tanks is exposed to air and light and filtered through soil. 794

In the 19th Annual Report of the Massachusetts State Board of Health for the year 1887, there is a description illustrative of a sewage disposal system in operation at Medfield, Mass., which works comprise the use of a settling basin which I now call a septic tank, a cesspool and an intermittent sand filter. I will quote from page 100 the following words:

"To exclude the spent dye-wood from the sewer
there was built adjacent to the dye-house a settling
basin with a filter, whose construction may be
understood by aid of the accompanying drawing
(Plate II). It is made in two parts, side by side,
796 exactly alike, in order that one-half may be in use,
if necessary, while the other is being cleaned out.
The discharge from the vats can be turned by a
wooden gate in the trough which brings it from
the dye-house into either side of the settling basin
separately. Entering by the 4-in. openings the
liquid flows generally in both sides with a total
width of 10 ft. and a depth of 4 ft. less the thick-
ness of the deposit of sediment. The velocity of
797 flow is thus checked and the ground dye-wood has
a chance to settle. To get into the second pair of
compartments it has to pass over the brick divid-
ing wall whose elevation is the same as the bottom
of the inlet pipe. Here is another opportunity for
settlement to take place, but apparently very little
collects in these second compartments until the
first are pretty well filled. In the third compart-
ments by tight board partition the liquid is obliged
798 to pass downward and escape by upward filtration
through a mass of excelsior held between two sets
of wooden slats; as exhibited by the drawings, the
upward flow being preferred as a precaution
against choking the filter. The filter was in use
nearly a year before the excelsior was changed. It
worked very satisfactorily, but the excelsior had
by that time become so rotten that probably it
would soon after have gone to pieces and escaped
799 through the sewer. A new supply was accordingly
substituted. The sediment needs to be shoveled
out and carted off once or twice a year; It has a
similar appearance to sawdust except for its black
color."

These words describe a tank operated in such a way as to promote substantial septic action. The rotting out of the excelsior is evidence of anaerobic decomposition. I will now quote from page 101 of the same Report:

"Near the lower end of the sewer the sewage passes through a cesspool arranged as shown on the accompanying drawing (Plate III) so that the outflow takes place from beneath the surface of the sewage standing in the cesspool. The effect is
that objects which either float or sink are held back 801
until they are sufficiently changed by chemical or other action to flow uniformly with the rest of the liquid, and are prevented from being thrown out upon the ground at the outlet, where lumps of foecal matter, orange peel, and the like, might be offensive or ill-adapted for percolating through the ground. Very little sediment collects in the cesspool, only about one feet in depth in the course of
a year. When it fills up the sediment will have to 802
be taken out."

I understand these words to describe a tank in which the septic action was intentionally sought and obtained. From this cesspool or septic tank, which I understand received the sewage of the town, the sewage was conducted to inter-
mittent filters where it was exposed to light and 803
air and purified. Since the septic action was intended in the cesspool, it follows, although not specifically mentioned in connection with the settling and filter tank above mentioned, that the putrefactive process was probably contemplated in the said filter tank. I have made a copy of
the said filter tank and cesspool accompanying 804
said report, and herewith present it. The drawing is entitled "Page 100, State Board of Health, 1887."

One of the first applications of the Philbrick design for the intentional utilization of the putrefactive process, insofar as it macerated and

finely divided the solid matters, was at the Lawrenceville School, Lawrenceville, New Jersey. The plans for the plant were designed by Mr. J. J. R. Croes and were constructed in 1885. These works as designed and constructed were described and illustrated in a paper read before the
806 American Society of Civil Engineers, June 16, 1886, and published February, 1887, in the Transactions of the Society. My understanding of the works so described and illustrated is as follows: The sewage was collected by cast iron pipes to a sewage tank built of brick and arched over and covered by soil, the tank being divided
807 into two sections; the first or retaining section being in duplicate and containing 6 compartments, 3 in each set, each compartment being 60 feet long, about 3 feet wide, and 4 feet deep. The sewage entered at one end of the first compartment, passed along its whole length, and thence into the second compartment through a submerged
808 quarter-bend pipe with the mouth turned down below the level of the sewage to prevent scum on the surface of the liquid from passing over into the second compartment. In this compartment the liquid passed through to its further end, and then in like manner through a submerged pipe into the third compartment, and
809 along its length to the further end thereof, where it passed over a wier into the receiving reservoir. This receiving reservoir comprised the second section of the tank, it being circular in form, 25 feet in diameter and 8 feet deep, its purpose being to collect the clarified sewage and

hold it to facilitate pumping and the intermittent dosing of the liquid on the connected irrigation area. This reservoir was ventilated by a pipe leading into the flue of the boiler house chimney. The sewage pumped from this reservoir was delivered through 2-inch agricultural
tile, laid about 8 inches below the ground in the 811
irrigation area, and thus supplied to the soil intermittently. Septic action occurred in this tank, or the first part thereof.

On page 507 of the said Rafter & Baker book, is a chapter devoted to "Intermittent Filtration at the
Massachusetts School for the Feeble-Minded." 812
This plant was completed in 1889 and was designed to accommodate about 150 inmates. I will quote as follows:

"From the Custodial Ward Building and the Laundry just south of it the sewage is conducted into a brick sludge-trap,shown in detail by Fig. 89, where it halts until the grease has risen in a scum
to the surface, the insoluble matter settled to the 813
bottom, and the paper, etc., become broken up and held in suspension. The 6-inch inlet enters about a foot above the surface of the sewage. From the sludge trap a 4-inch ventilating pipe runs into the boiler-house chimney. The 5-inch iron overflow from the sludge trap to the detaining tank is T-shaped, and so placed as to allow the effluent to pass over from below the scum of the grease on the
surface and from above the sediment at the bottom 814
of the sludge trap. An 8-inch iron pipe and gate at the bottom of the sludge trap permits the grease and sediment to be run off to a composite heap as often as may be necessary—probably about once in three months."

This tank operated in this way would comprise substantial septic action.

815

From the sludge trap the sewage passes into a
brick collecting chamber acting as a dosing tank
and distributing the sewage over the surface of
intermittent filters where it would be exposed to
light and air.

The Brockton sewage tank was designed in 1892,
816 and built in 1893 for the purpose of storing the
night flow of sewage to facilitate pumping and dis-
posal upon the sand filters. The tank was pro-
vided with facilities for the separation and subse-
quent handling of the solids, apart from the liquid
portion of the sewage. The heavier portion of the
sewage, termed "sludge," is pumped on to filter
817 beds devoted to that purpose and termed "sludge-
beds" and the supernatant liquid is pumped on to
beds receiving only this kind of sewage. The sew-
age enters the tank near the bottom thereof through
a pipe having three openings, one in the middle of
the tank and each other about two-thirds the dis-
tance from the center to the end to the left and
818 right of the center. At the opposite end of the tank
the sewage enters through a pipe in the bottom of
the tank to the pump well, where it is forced upon
the filters. The bottom of the tank slopes to this
pump well, into which the sludge gravitates after
the lighter portions of the sewage have been drawn
off and pumped upon the filter. Defendant's plant
819 was an outgrowth of the Brockton plant. In both
a tank is used to separate the solids from the
liquids. In both large sludge-beds are provided
upon which to dispose of large quantities of solids
accumulated in the separating tank, and in both
the supernatant sewage is purified on beds devoted
to the clarified sewage. In defendant's plant, how-

 820

ever, the well known solvent action, as in the tanks of Muller, Mouras, Waring and Philbrick is intentionally taken advantage of, but this principle in defendant's plant is incident to the process of separating the solids from the liquids and not by any means absolutely essential to the success of the plant. Defendant's tank, like the Brockton tank, 821
is primarily an apparatus for settling out the solids from the liquid sewage. The Brockton plant was described by me in a special report made and published in 1893 and illustrated by plans.

These instances of tank use in the United States are cited as a few of many types to be found in practice. The elements of defendant's plant have all, 822
either singly, or in various combinations, been commonly practiced in the art of sewage disposal.

I will now refer to the Exeter Tanks, which were designed to utilize the well known solvent action in sewage, which tanks were first called "septic tanks." I will also refer to the patents taken out in connection therewith. 823

Adjourned to Thursday, June 15, 1905, 10:30 A. M.

New York, June 15th, 1905, 10:30 A. M.

Met pursuant to adjournment.

Present, counsel as before.

Examintion of Mr. Snow continued:

(Witness continues his answer to Q. 26). 824

My information about the Exeter experiments with the old-time process of arresting in a tank the solids in suspension in sewage for the purpose of taking advantage of the solvent action going on therein so as to make the filtration of the effluent practicable, has been obtained chiefly from the

report now before me entitled, "Interim Report of the Commissioners appointed in 1898 to Inquire and Report What Methods of Treating and Disposing of Sewage (Including any Liquid from any Factory or Manufacturing Process) May Properly be Adopted. Vol. II. Evidence." "Presented to
826 both Houses of Parliament by Command of His Majesty." "London: Printed for His Majesty's Stationery Office by Wyman and Sons, Limited, Fetter Lane, E. C. And to be purchased, either directly or through any Bookseller, from Eyre and Spottiswoode, East Harding Street, Fleet Street, E. C., and 32, Abingdon Street, Westminster, S.
827 W.; or Oliver and Boyd, Edinburgh; or E. Ponsonby, 116, Grafton Street, Dublin, 1902."

Beginning on page 101 of said report is a full account of the examination by the said Commission of Mr. Donald Cameron, City Surveyor of Exeter, who conducted the experiments. This testimony was begun on the 18th of October, 1898, and con-
828 cluded the following day.

The first experiment was tried with a small tank covered over and 12 feet long by 15 feet wide by 2½ feet deep, dealing with the sewage of about 30 houses. No filters were attached to it. In this tank very little deposit was found in the bottom, but a very large thickness of scum formed on the
829 surface of the water. The experiment was begun on this small scale, on April 5th, 1895. On November 8, Mr. Cameron applied for a patent.

British patent No. 21, 142, A. D., 1895, was accepted April 25, 1896. The application was by Donald Cameron and Frederick James Commin, in which it is stated that the invention relates to the treatment of sewage and to apparatus therefor, and has for its principal object to deal with crude sewage, bacteriologically, and bring it into such a condition of solution and liquefaction that it can be treated by filtration or irrigation or in any other suitable way. On page 9 of the application it is stated: 831

"By this invention further it is possible to get rid of the sludge difficulty because the solid portion of crude sewage is entirely thrown into solution.

"In the system now employed the crude sewage is first treated chemically so that the solid matter is to a great extent precipitated and it is only the liquid part which is treated by filtration or otherwise. 832

"By this invention the chemical treatment is entirely dispensed with and further the expense of dealing with the precipitated matter is also obviated. In previous systems it has been considered of advantage that there should be contact of sewage matter with the air. In the treatment of sewage according to our invention it is of the utmost importance that the chamber in which the bacteriological action takes place should be dark and also 833
that means should be provided for preventing contact with the air. This want of contact with the air can be arranged by providing a closed cover to the tank or vessel or in certain cases by having no cover but by utilizing the formation of scum which occurs when sewage is treated according to this invention. In carrying out this invention we provide or construct a tank of concrete, brick or other suitable material preferably shallow compared to 834
its other dimensions. In order to ensure exclusion of air we make the cover air-tight and the man-hole solid and air-tight. It may be found desirable to have a valve in the man-hole to allow at times of the escape of gas should the fermentation bacteriological action take place too rapidly. The inlet pipe and outlet pipe into the tank should be preferably trapped. The inlet pipe should be so

835 arranged that it discharges into the tank some two or three inches below the normal surface of the water so as to avoid breaking the scum which forms. For the same reason the outlet pipe should be from the top of the tank, but trapped and carried down below the surface so that the floating matter is retained in the tank. The bottom of the tank
836 may be provided with a small channel or it may be dished so that the mineral or other insoluble matter may be collected there and taken out as required.

"We have found by experiment that the tank should be of a capacity to hold about 20 gallons per head of population but we do not bind ourselves to this. After such a tank has been for 2 or 3 days in operation a brown scum forms at the top and
837 eventually becomes 2 or 3 inches in thickness. This scum is formed by bacteriological action and rises in particles from the bottom of the tank; gas forming at the bottom and carrying these small particles with it to the top of the tank. After such a tank has been in operation for 2 or 3 days the effluent is satisfactory and is in a condition to be further treated by any other means such for example as a coke-breeze filter.

838 "By this invention crude sewage can be treated for long periods and there is at the end of such time practically no sludge at all in the tank.

"We have also tried baffle plates in the tank these plates being made of wood; but up to the present we have not found that such baffle plates add to the bacteriological action."

I wish to point out the remarkable claim in this specification that by this invention

839 "It is possible to get rid of the sludge difficulty because the solid portion of crude sewage is entirely thrown into solution."

While this was claimed for the Mouras tank, it is more than that claimed for the Waring and Philbrick liquefying tanks.

I wish also to point out that the patent specifies no particular class of bacteria by which the process of the patent is brought about, the object of the invention being:

"To deal with the sewage bacteriologically and bring it into such a condition of solution and liquefaction that it can be treated by filtration or irrigation, or in any other suitable way." 841

In some of the other liquefying processes hereinbefore described by me, the class of organisms accomplishing the work is mentioned.

I wish to call attention that in the treatment of sewage according to this invention, it is of the utmost importance.

"that the chamber in which the bacteriological action takes place should be dark and also that 842
means should be provided for preventing contact with the air."

I wish also to call attention to the manner this darkness and want of contact with the air can be arranged. In line 33, page 2, it is stated:

"By providing a closed cover to the tank or vessel or in certain cases by having no cover but by utilizing the formation of scum which occurs 843
when sewage is treated according to this invention."

I understand this to mean that in cases where there is no formation of scum the treatment could not be considered the one and the same treatment described in the said patent because the patent states: 844

"By utilizing the formation of scum which occurs when sewage is treated according to this invention."

Later, as I will show, Mr. Cameron gave it as his opinion that fermentation would go on in open tanks even if there were no formation of scum visible.

I wish also to call attention to the statement about the formation and thickness of the scum in the treatment of sewage according to this invention. On page 3, line 2:

"After such a tank has been in operation for two or three days a brownscum begins to form at the
846 top and eventually becomes two or three inches thick. This scum is formed by bacteriological action and rises in particles from the bottom of the tank."

So it is seen by this statement that the bacterial action is evidenced in from two to three days after the tank is put in operation by the brown scum which begins to form. Again on line 5, page 3; I
847 wish to call attention to the time required for the sufficient freeing of the sewage from suspended matter to render it in a condition to be further treated:

"After the tank has been in operation sufficiently long for this scum to commence forming, the effluent is so free from matter in suspension that it is in a condition to be further treated by any other
848 means such, for example, as coke-breeze filters, or for irrigation or discharging into rivers and tidal watres."

Since the scum begins to form in two or three days the bacterial action is complete enough for the purposes of the said invention. I wish to call special attention to this view of the practical opera-
849 tion of the invention as understood and intended and described in the said patent.

In regard to the apparatus of said invention I will quote from page 3 as follows:

"*a* is the tank constructed of any suitable material, but we recommend cement-concrete. It is shallow in comparison with its other dimensions. *b* is the tank cover which is made air-tight. *c* is the

man-hole in this cover also made air-tight. *d* is the inlet to the tank; it is shown as trapped and provided with an inspection eye and cover at *e*. It discharges into the tank some distance below the normal water level as shown so as to avoid breaking the scum which forms in the tank. *f* is the outlet from the tank; it is at the upper part of the tank but is carried down below the surface as 851
shown so that the floating matter or scum is retained undisturbed in the tank. The outlet is represented as discharging on to a table *g* surrounded by a low weir *h*; this ensures that the effluent will spread in a thin film over the weir which is of great assistance in purification. The bottom of the tank is shown as inclined towards one and where there is a sump *j* in which mineral or other insoluble matter will collect and from which it can be removed 852
from time to time. It is not absolutely necessary for the tank to have an air-tight cover as above described because the dark scum which forms serves to keep both light and air from the sewage, but we consider it important to provide the cover."

Recess.

I will refer to line 41, page 2 as follows:

"The inlet pipe and outlet pipe into the tank should be preferably trapped." 853

This is shown in the drawing of the patent to be accomplished by one pipe for the inlet, *d*, and by one outlet pipe, *f*, and the weir, *h*.

I wish to call attention to line 27, page 3:

"The outlet is represented as discharging on to a table *g* surrounded by a low weir *h*; this ensures that the effluent will spread in a thin film over the weir which is of great assistance in purification." 854

This use of a weir for assisting in the purification of tank effluent was common in the art prior to this time some instances of its use of which I have hereinbefore mentioned.

The second experiment at Exter was with a tank about double the capacity of the first one. It was

855

started in January, 1896, to show the Corporation what could be done by this system of disposal. Two coke-breeze filters were attached and operated at a rate of about 1,000,000 gallons per acre daily. As the result of the working of this installation, the Council decided to construct larger works to
856 show to the Local Government Board the system on a practical scale. This last experiment which is the one referred to hereafter, unless otherwise stated, was started July 21, 1896. Dibdin contact beds were attached and operated by automatic apparatus invented by Mr. Cameron. For the perfected system and apparatus, the British patent, No. 23,-
857 042, A. D., 1896, was granted to Donald Cameron, Frederick James Commin and Arthur John Martin. The application was filed October 17, 1896. Eight months after, on June 18, 1897, the complete specification was filed. This patent relates to various improvements in apparatus. One of these improvements relates to means for discharging the
858 contents of a vessel or tank along an extended line, so as to avoid concentrating the flow to a point or points. I will quote from line 27 of page 4:

"This consists of a pipe or conduit 10 following the line along which it is desired that the contents of the tank or vessel A shall be discharged, and having throughout its length, or a part thereof, a slot or aperture, or a series of apertures by which
859 liquid may enter the said pipe or conduit. Such slot or apertures may diminish in size towards the outlet or outlets from the said pipe or conduit, so as to avoid an excessive rate of flow thereinto near such outlet or outlets, thus maintaining a uniform flow into said pipe or conduit throughout its length.

"The slot or apertures may be placed in any position along said pipe or conduit so as to admit liquid into the same in a downward, upward, horizontal or oblique direction, as may be desired.

"If desired or found advisable the slot or apertures may be protected by a deflecting surface or surfaces so placed as to ward off solids or liquids coming from any particular direction.

"The slot or apertures may also be provided with a strainer for the exclusion of solid matter. 861

"The pipe or conduit may be fixed or movable."

This improvement, the patent states, applies to the discharging of the contents of an improved tank for the treatment of sewage or other liquid, in which tank the sewage may be treated either chemically, bacteriologically, or otherwise as desired, (*See* line 8, page 5).

Slotted pipes may be placed on the bottom of the tank for the removal of mud or other deposited material. This is another improvement over the first patent. These or other pipes may be used to impel a stream of fluid against deposited material to dislodge it or break it up. 862

And the patent provides for various other devices for delivering the liquid from the tank onto 863 filters and for controlling filters. I will quote from line 33, page 5:

"Transverse partitions or screens may be used, extending through the whole or a part of the cross-section of the tank, to arrest floating or suspended matter."

The patent also provides for a grit chamber outside of the tank, and also for a special arrangement of tank. 864

On page 5, line 5, the course of the sewage through the improved tank which may be used as any kind of a tank, is described as follows:

"In the arrangement shown in Figs. 1, 2 and 3, the sewage or other liquid coming through the

sewer 13 is delivered into a well 14, where grit and other solid matters are allowed to settle. It then passes through the pipes 15 and 16 into the tank *A* in which it may be treated either chemically, bacteriologically, or otherwise, as desired. After treatment in the tank *A* it passes into the pipe or conduit 10 through slots or apertures provided for
866 the purpose, the effect of which is that it is evenly delivered all along the line of the opening or openings into the pipe or conduit, and concentration of the flow to one or more points is avoided. From pipe or conduit 10 the effluent passes through pipes 17 (which may, if desired, be provided with suitable valves) into the aerator 18, which is provided with a series of nearly level surfaces, over which the effluent flows in thin films, or with an overhanging lip or lips from which the effluent falls
867 in a thin film or films exposed on both sides to the air. From the aerator the effluent may, if desired, be conducted to a filter or filters for further treatment."

I wish to call attention to the fact that all these elements, with the exception of the particular slot in the pipe of the patent, have been used in tanks hereinbefore mentioned and described by me.
868 I wish to call attention also, to the fact, that nowhere in the patent is it specified what kind of bacteria it is the object of the invention to utilize when the sewage in the tank is treated bacteriologically.

It is in this patent that the term "septic tank" is first used, it appearing in the application, dated
869 October 17, 1896.

Mr. Cameron's knowledge of the so-called septic treatment is set forth in his testimony before the said Royal Commission on Sewage Disposal. I will quote some of the questions and answers appearing in said report, beginning on page 101 thereof: First, as to the object of the method:

"1862. Would you give us a short description of the objects of those methods of sewage disposal?

"The aim I had in view was to bring the sewage into such a condition by arresting the solid in suspension as to make the filtration on artificial filters practicable; at the same time taking advantage of the solvent action that goes on in the arrested solids, so as to make the quantity of deposit or 871
sludge as small as possible."

In reference to the amount of liquefaction of the solids, (page 104):

"1891. Now one of your main principles is, I believe, the complete or the almost complete liquefaction of all solids in the sewage by fermentation set up by the action of anaerobic bacteria, is it not?

"This last year's estimation showed that 80 per cent. of the suspended solids were got rid of in that 872
way."

With respect to whether closed tanks are necessary:

"1892. Do you believe that without your closed tanks this anaerobic bacteria would either not come into existence, or would cease to exist too soon?

"I am not qualified to speak upon this question; 873
I am not a bacteriologist, and I can only give my own uninformed opinion upon the matter."

With respect to whether aerobic organisms are able to work under the conditions in his tank:

"1893. Oh, yes, quite so?

"But I found a paper was read by Dr. Adney, of Dublin, before the Congress of The Sanitary Institute at Birmingham, last month, and he defines in 874
it what anaerobic fermentation is. His definition is: 'We may take it, from what has already been said, that a river becomes over-polluted when the bacterial fermentation in its waters becomes so rapid that the atmospheric oxygen dissolved in them is consumed by the bacteria more quickly than it can be replenished in the ordinary way, that is, by ordinary solution and effusion through the

water of fresh quantities of oxygen from the
atmosphere. When this state of things arises
anaerobic fermentation sets in, attended with all
the offense and dangers of putrefaction."

"With regard to sewage, if this definition is cor-
rect, and I have no reason to doubt it is—because
I think Dr. Adney has contributed more to this
876 subject than any other who has taken it up—if
this definition is correct, then anaerobic conditions
exist in the sewage from the outset. Dr. Dupre
has shown that thirty times the volume of river
water will render sewage innocuous, it would be
necessary then to supply that quantity of water
under the conditions stated by Dr. Adney to pre-
vent or put a stop to putrefaction, or a supply of
oxygen must be given artificially. Again, the ex-
877 periments made and carried out by the Massachu-
setts Board of Health show that the organisms
isolated from the sewage, with very few exceptions,
thrive in the presence or in the absence of air
equally well. Whether the organisms coming in
with the sewage into this tank get their supply of
oxygen from the surrounding organic matter, they
certainly, I do not think, get it from the atmo-
sphere, but whether they are aerobic organisms
878 that are able to work under the conditions in the
tank I am not able to say."

Mr. Cameron made this statement on October 18,
1898. Further, in respect to this matter:

"1894. You are not able to say whether they are
altogether aerobic or anaerobic?

"No, or whether they are able to exist under
these conditions. The only thing that I have been
879 able to notice has been that after putrefaction had
become evident, the number of microbes declined
and became very few, and again after putrefaction
was over the number seemed to increase. These
are from my own crude observations on the sub-
ject. But one thing I should like to say—I dare
say it will be put before you better than I can pos-
sibly do it—but my difficulty has always been to
realize how a visible particle of suspended matter

in the sewage compares with the size of the organisms, how the one can be seen by the eye, but the other requires a twelfth eye-piece to be able to see it, and that, therefore, if anaerobic conditions are not to be allowed, I do not see how this sewage can be broken down."

As regards the nitrifying action in the filters, (page 106): 881

"1927. Could you give us any description corresponding to the anaerobic treatment in the tank of the aerobic treatment in the filter?

"No, My Lord, further than so long as the effluent is in such a condition that it could be filtered without mechanically clogging the filter, I do not follow the subject, and the question of nitrification is one of which I have no knowledge practically.
As regards the filters I adopted Mr. Diblin's 882
method. The only thing I can say in addition to this, that besides the chemical action that goes on in the filter there is always an undoubted straining action, and that the filters hold on their surfaces the fine matters that come out of the tank."

With respect to whether anaerobic fermentation ceases when the scum is destroyed:

"1935. (Professor Ramsey) I wish to ask 883
whether Mr. Cameron has noticed whether putrefaction goes on equally well in a septic tank when the sewage is exceedingly dilute?

"I have got the impression that the action is not so rapid when the sewage is diluted.

"1937. Then another point I wish to ask about is the anaerobic fermentation in the open tanks. I want to know if he has noticed whether anaerobic fermentation will go in tanks? 884

"I think it will. My first idea was to use only an open tank and not a covered tank, and so long as the scum is formed on the surface I think anaerobic fermentation is going on.

"1938. Does anaerobic fermentation cease when the scum is destroyed?

"I do not think it does; the production of gas does not cease.

885 F. HERBERT SNOW.

"1939. Were your original tanks covered?
"All of them.
"1940. From the very first?
"From the very first, yes."

Mr. Cameron first found out that his so-called septic tank would require cleaning out in Septem-
886 ber, 1896.

With respect to this, (page 107):

"1959. You anticipate, therefore, that it will be necessary from time to time to remove the sludge, this accumulation of sludge?

"At first I gave particular attention to the accumulation of the sludge, and for the first two months it increased at the rate of one inch per month. Then I considered that we should have at
887 some period or other to clean out the body of the tank."

With respect to the speed of flow in the tank:

"1962. And up to what speed per minute do you think you could go without interfering with the efficiency of that tank?

"I propose that in the new works it should go up to the speed of five inches per minute, but I think
888 we could go very much higher than that without at all interfering with the action of the tank. When Dr. Dupre was asked that question he said 'He was afraid,' without calculating the speed at which the sewage passed through the tank, 'it would wash the living machine out of the tank.' But I afterwards pointed out that such a speed, that is, five inches per minute, could not possibly wash the deposit from the bottom nor the scum from the top, con-
889 sequently the living machine still remained in the tank."

With respect to the main advantages of his tank:

"1964. Now, comparing the work of the tank with the filter, you would claim, I suppose, that the work of the tank was mainly to get rid of the matters in suspension. You do not claim that the tank would do much more, do you?

"There is undoubtedly a change in the tank; the organic matter is undoubtedly changed greatly into ammonia, and into gas, which of itself is a very big change.

"1968. Then the main advantage you claim for the use of the septic tank is the destruction of the solid matter, and getting rid of the sludge difficulty?

"There is, besides that, another advantage, that 891
it smooths or equalizes inequalities in the sewage. An example may be given of the chlorine. At night the chlorine is found to be a little over 2."

Mr. Cameron states, in answer to question 1971, with respect to the filters, that

"Aeration is the secret of filtration, as far as I can understand it."

With respect to aerobic liquefaction in the filt- 892
ers:

"1972. The effluent from the tank contains in suspension very finely divided particles which you yourself speak of as humus?

"Yes."

"1973. Do I understand that you think that is matter which will necessarily accumulate in the filter—matter, that is, that can not be liquefied by 893
aerobic bacterial action?

"I think the particles of organic matter attached to these particles will be dealt with on the filter. The accumulation of these fine particles on the surface of the filter has necessitated in two years the removal, on an average, of two inches over the surface of the filter. I say an average, because the greater part of the deposit took place in the immediate vicinity of the channel where it had to be 894
taken a little deeper, but the average quantity which has had to be removed in two years has been two inches. * * * * * * *

"1974. The removal, I suppose, was necessary, because it stopped the passage downward of the effluent from the tank?

"It stopped the passage downward, or the rate of the passage downward, into the filter."

895

On October 18, 1898, Mr. Cameron did not know how much, if any, the solvent action in the tank helped the filters, except to reduce the solids going to said filters. With respect to this, (page 109):

"2014. Are you at all inclined to think that there are special changes taking place in your sep-
896 tic tank, not merely the general diffusion of several parts of the sewage, and not simply the mere solution of the solid matters, but changes by which the material of the sewage is made, so to speak, easier to be worked upon by the organisms in the filter?

"My view is that the water between the two layers, the top layer and the bottom layer is undoubtedly acted upon in its passage through the tank.

"2015. Quite so; beyond mere solution of visible
897 particles, or are you speaking only of the solution?

"I am speaking now of the parts in solution.

"2017. Then the material in solution is acted upon?

"Then the material in solution is acted upon.

"2018. And that action is of such a character as to facilitate the subsequent action of the filter?"

"Yes, undoubtedly the ammonias are increased; an unstable condition is set up.

898 "2019. That is the general view you have. Have you any special number of facts upon which you base it, or is it merely a general conception to which you have been led?

"That is a conclusion to which I have been led by the odor which arises at the outlet pipe.

"2048. Do you consider that the treatment in the septic tank is incomplete without the subse-
899 quent filtration?

"I do.

"2049. You would not advocate the provision of a septic tank and nothing else?

"Except on conditions, such as a sea outlet or into an estuary."

I wish to call attention to this answer.

With respect to aerobic and anaerobic action in the filter elsewhere than at Exeter, (page 110):

 900

"2059. I do not know whether this is within your province to give an opinion about. How do you account for the aerobic action in Dibdin's filters being apparently sufficient to break up the sewage without the previous anerobic action in the septic tank?

"I do not know whether Mr. Diblin contends that it is aerobic action or not, but Dr. Rideal 901
contends that it is an anaerobic action.

"2060. In the filter?

"In the filter, in the roughing filter, and Dr. Adeney's definition of anaerobic fermentation would also favor that view," with respect to the indefinite retention of the solids in the tank at Exeter.

"2063. In fact, they remained for an indefinite time?" 902

"That is so.

"2064. So that the tank is what you may call a tank of deposit; it slows down the current of the sewage and enables the suspended matter to subside in or form a scum on top?

"Yes.

"2065. And thereafter continuously goes through certain processes?

"Yes."

With respect to the size of tanks to get septic ac- 903
tion so-called, (page 111):

"2069. So that the best theoretical result that you can hope for from your tank is that the speed should be such as to permit of the subsidence of this suspended matter, or at any rate, of its stratification. You can work your tank at as high a rate as you please, provided it allows the sus-
pended matter to stratify itself? 904

"That is so. From the observations that were made of the tank at Exeter, I have come to the conclusion that it is too large for the work it has to do, and that is confirmed by Dr. Rideal's analysis, when he found traces of nitrates in the tank effluent, that is, that the tank was doing work which should really be done by the filter. The reason of its being so large is the attempt to deal with a certain amount of storm water as well as the normal sewage.''

With respect to so-called septic action going on in sewers:

''2070. These tanks are of historical interest to my mind, because it reminds me of what was called the 'sewer of deposit,' and I suppose it
906 shows that there is some good really in a sewer of deposit, or at any rate, some elements of good, that can be followed up and worked out with success in such a method as you have adopted?

''I always looked upon the smell arising from a manhole as being caused by decomposing deposit in the immediate vicinity, and I have always looked upon that as objectionable, and provided flushing apparatus for removing it instead
907 of ventilating apparatus for diffusing the gas in the town. In a trunk sewer there is a certain amount of decomposition going on undoubtedly.''

''2071. So that it is simply owing to the length of flow through a sewer. If the sewage of a town happen to flow to works for a mile or two—if you can imagine such a thing for the present purpose—then the sewage would be more nearly in the state which you aim at than
908 if it were taken immediately the intersepting sewer began?

''I conclude that less stay in a tank would be necessary under such conditions.''

I wish to call special attention to these questions and answers, as a recognition of what I have herebefore stated was the general knowledge of the so-called septic action occuring in sewage:

909 Still further on this point:

''2079. * * * * Another historical point of interest is that this particularly amounts to making the sewage as stale as possible before bringing it to the place of final treatment, whereas, if I mistake not, we used to be told that the fresher the sewage was brought to the place of treatment, the better it was for agricultural purposes?

"Yes, but in Exeter the sewage is very fresh as it comes to the tank; it is a short distance, with rapid falls.

"2080. So that your tanks have to do really all the work?

"All the work, practically.

"2081. Whereas in some places a good deal of it would be done by intercepting sewers? 911

"Before it arrives at the works."

With respect to odors and aeration, (page 114):

"2158. So that the effluent from the precipitating tanks would not be so stable as the effluent from your septic tank?

"The effluent from the precipitating tanks is stable to a certain extent; more stable than the effluent from the septic tank, which is in a very unstable condition—the smell from the effluent 912 very quickly disappears. It has been observed by several people that from the time it comes out from the aerator here on plan to the furtherest away filter the smell has almost entirely disappeared, and whatever is done to the effluent, however it is treated, the tendency is to become pure if allowed to absorb air."

Mr. Cameron states that his opinion about the purification by aeration is based wholly upon his 913 observation from the senses, that he has had no chemical examination made of the effluent after it leaves the tank between that time and the time it falls on to the filter. I wish to call especial attention to this statement. Speaking broadly, he says that the two great changes of putrefaction and nitrification divide at the tank, the nitrifying action ap- 914 pearing to begin directly after the effluent leaves the tanks.

Adjourned to Friday, June 16, 1905, 10:30 A. M.

915 F. Herbert Snow.

New York, June 16th, 1905, 10:30 A. M.

Met pursuant to adjournment.

Present, Counsel, as before.

Examination of Mr. Snow Continued:

XQ. 27. Mr. Cameron referred to the Massachu-
setts Report, concerning organisms thriving in the
916 presence or in the absence of air equally well. What
was the attitude of the said authority on the septic
action in sewage as published in the said Report?
A. The earlier Massachusetts experiments were
not directed towards the exclusive putrefactive pro-
cesses, but towards the nitrifying ones. It was
sufficient at first to conclusively prove that oxidiz-
917 ing or aerobic agencies were ample to completely
break up and mineralize organic matter, sludge
and all. In the State Board of Health, 1893 Re-
port, the first distinction between fresh and other
sewage was made by calling attention to the pres-
ence of dissolved oxygen in the former and its ab-
sence in the latter. It was also observed that fresh
918 sewage, was harder to purify, because it contained
a larger proportion of organic matter in suspension.
The bacterial process following this initial step in
sewage purification was shown to be evidenced in the
arrangement of the free ammonia, organic nitrogen
and by the loss of carbonaceous matter. In other
words, in stale sewage—one containing no free
919 oxygen and in which the facultative anaerobes do
the work generally called putrefaction there is a
loss of crude organic matter by the reduction of
carbonaceous bodies and the changes of organic
ammonia to free ammonia. The fact that the per
centage of suspended organic matter present in sew-
age decreases with the increase of age of the sew-

age and that stale sewage is more easily disposed of upon sand filters than fresh sewage, was repeatedly stated in the four Annual Reports of the said Board, prior to its first use in 1898 of the term "septic," in respect thereto.

The adoption of the term "septic" became necessary owing to the general use of it, since the publication of the Exeter experiments herein referred to. 921

This condition came about by the pat application of the term "septic" to a very old principle (in contradistinction to the term antiseptic which had been generally applied to many prevailing English works or processes), advocated as an absolute solution of the sludge question just at the time when everybody in England was beginning to direct his attention to the bacterial disposal of sludge. 922

Q. 28. Both Mr. Scott-Moncrieff and Mr. Cameron differentiated between the preliminary change in sewage and the final one of oxidation, as well as Adeney, Phillbrick, Waring, Mouras and others. 923
Give a brief statement of the knowledge of the bacterial chemistry of these processes at about the time Mr. Cameron gave his testimony before the Royal Sewage Commission? A. There were three dominant opinions. It was agreed that the septic tank, by means of its bacterial enzymes or spontaneous chemical decomposition, materially altered 924
the composition of the raw sewage. The increase of the total solids in the liquid pointed to a solvent action of its water on the matter in suspension, due to a digested or purely physical process; but the marked disappearance of organic matter and transferrence of organic nitrogen to free ammonia was

due to bacterial influences. The adherents of one dominant opinion held that the bacterial transformation of sewage occurs in more or less distinct stages enumerated as the "initial stage" or the transient aerobic one. The "second stage" or semi-anaerobic breaking down of the intermediate
926 dissolved bodies, and the "third stage," or complete aeration and nitrification.

These adherents advocated anaerobic treatment as the essential process for the destruction of solid organic matter and so were not prepared to call the destruction or dissolving of organic matter in Dibdin's coarse bacteria filter, aerobic
927 in character. The action must be, they held, anaerobic under aerobic conditions, since it was hydrolic. In the contact filter there were the opposing aerobic and anaerobic actions. The "resting full" period diminished the aerobes and the "resting empty" period diminished the anaerobes. This oscillation, it was held, tended
928 towards defeating the very object of the filter. A preferable system was one in which anaerobic work is done separately, under uniform conditions, and the same respecting the aerobes. Therefore, in constructing sewage disposal apparatus according to this view, it should consist of two parts, one for the preliminary anaerobic
929 action, and the other for the subsequent aerobic action.

Another dominant opinion took the position that the supporters of anaerobic fermentation were working under pure hypothesis and that results could be explained in another way. Organic matter underwent two successive organic

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and distinctly different stages of chemical change, a fact of practical value, because the second stage of fermentation presented little danger to river water, while the first stage in the absence of sufficient oxygen invariably sets up putrefaction. Aerobic fermentation will take
place in sewage to the exclusion of anaerobic, so 931
long as the supply of oxygen is present, and further, the conditions under which bacteria affect chemical changes most rapidly, is that in which oxygen is supplied to them in the atmospheric form, in which form the fermentations are unobjectionable to the senses. This view, therefore,
supported aerobic fermentation in preference to 932
anaerobic, while not denying the latter.

Another dominant opinion profoundly summed up the subject as a process of change brought about only by living fermentation. If evil smelling gases are produced, then fermentation is often called putrefaction. But attempts to sepa-
rate, artifically, as in practice, putrefaction from 933
fermentation and restrict the former to the breaking down of matter, and to distinguish between putrefaction which gives off no evil odors and putrefaction which does give off evil odors, is fallacious. No such lines can be drawn. Putrefaction is merely a particular case of fermenta-
tion and the most comprehensive definition of 934
fermentation is—change produced in various bodies by the action of living organism. Many bacteria are aerobic and many others are anaerobic, and there is a point somewhere between these extremes, called the optimum, where the actions are going on at their best, and, of course,

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the thing to do is to find out their optimum condition. In addition to these are the extraordinary physiological class of bacteria called facultative anaerobes, which can be either aerobic or anaerobic, according to circumstances. It is possible for anaerobic fermentation to go on near
936 the oxygen supply, like at the surface of liquid—for instance, the surface of a stagnant pool—provided some other organism protects the anaerobe from the oxygen. That is to say, the physiological action is going on in a different direction from the direction in which either of these alone would carry it. So that "symbiosis," as it is called,
937 comes to mean the action together, of two living organisms, where the action of each does not hinder, and in most cases helps the other. This was held by the adherents of this view to explain the disappearance of so much crude sludge in Dibdin's coarse contact filter acting under aerobic conditions. And as also explaining the
938 action taking place in Scott-Moncrieff's cultivating filter," and in fact, the action taking place in all processes of sewage purification where solids and liquid impurities are reduced to their lowest form. Considering the complex fermentations existing in a mixture like sewage, symbiosis must be going on at various points, according to
939 whether the sewage is in motion or quiet, or deep or shallow, &c. So the attempt to uphold putrefaction as a particular process, in which evil smelling gases come off by the agency of anaerobic organisms only, must fail. Either kind of fermentation, aerobic or anaerobic, may produce putrefactive gases. The adherents of this view

therefore concluded that it was not necessary to provide for the destruction of sewage in special anaerobic compartments. The anaerobic process is not the normal one in the events of nature. The nitrate is the desired goal of the change and the antecedent phase to the nitrate is always an am-
monia phase. The reduction to ammonia is ac- 941
complished by a large variety of organisms, some working in an aerobic and others in an anaerobic way. It is not necessary, therefore, that the process should be one of exclusive anaerobic condition. The aerobic organisms will bring all but the cellulose bodies to the ammonia condition
most rapidly. 942

Q. 29. Give a brief statement of what is now known about anaerobic action in sewage disposal works? A. A limited period of anaerobic action is advantageous. It may occur in a filter or in a tank. It prepares organic matter for the oxidizing bacteria. Causes the larger particles of suspended
matter to break up; dissolves a part of them or lib- 943
erates in gaseous forms, the remainder being finely divided; such effluent can be purified at higher rates than fresh sewage. Sewage properly designated septic sewage, that is, after being treated in a so-called septic tank, may be treated bacterially by filtration at the following rates in gallons per acre
daily: 944

Plain sand filtration.......40,000 to 150,000 gals.
Sand filtration sewage sprayed on....300,000 gals.
Contact filtration........660,000 to 800,000 gals.
Sprinkling filtration. . . . .1,400,000 gals.

Too advanced a stage of anaerobic action is a disadvantage. Such liquid absorbs oxygen in a

filter or otherwise before nitrification can take
place. Toxic bodies therein kill the nitrifying
organisms. It is known that a septic tank accumu-
lates sludge and requires to be emptied.

Further, anaerobic filters are successful, give
better results than similar tanks without bedding
946 material therein because they furnish greater sur-
face for bacterial growth, but they are more diffi-
cult to keep in working order than the plain septic
tank.

Contact filtration supports both anaerobic and
aerobic fermentation. This cycle is advantageous.
It lessens clogging and promotes more rapid puri-
947 fication. When the filter is drained, oxidation of
intercepted matter proceeds until exygen is all used
up. The resulting products—carbonic acid, marsh
and nitrogen gas, fill the open spaces of the filter.
Marked anaerobic action begins at this point and
continues until the bed is filled and drained again.
The filter material must be coarse enough to pass
948 suspended matter or it will accumulate and require
physical removal. Clogging should be minimized
by preliminary sludge removal. The methods in
order of preference are septic, plain subsidence,
and straining tank. Mineral matter must pass
away in effluent to ensure perfect permanency. The
filter should be filled with sewage once daily only.
949 Successive appplications instead of steady flow,
best way of filling. This allows a greater degree of
aeration. In double contact the fine filter may be
of lesser aera than the coarse filter. A contact
filter should be drained before the oxygen is all
exhausted, and the time limit should not be over
two hours from complete flooding.

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Stale sewage in which the suspended solids have been preliminarily treated by different methods may be filtered bacterially at the following rates in gallons per acre daily:

Plain subsidence	Sand	150,000		
Chemical subsidence	"	200,000	360,000	
Coke Straining	"	320,000		
Gravel filtration (aided by current of air	"	660,000		951
No treatment	Spraying Coke	600,000		
" "	Double coke	600,000		
Plain subsidence	Continuous aerobic Broken stone	1,400,000		

Counsel for defendants offers in evidence printed copies of the specifications and drawings of the following U. S. Letters patent. 952

No. 138,250, to F. Hille of April 29, 1873, the same being marked "Defendants' Exhibit Hille U. S. Patent."

No. 108,664, George W. Wigner, October 25, 1870, the same being marked "Defendants' Exhibit Wigner U. S. Patent."

No. 184,099, to G. R. Moore, November 7, 1876, the same being marked "Defendant's Exhibit Moore U. S. Patent." 953

No. 258,744, to A. S. Glover, 1882, the same being marked "Defendant's Exhibit Glover's First patent."

No. 280,545, to Silas Willcox, July 3, 1883, the same being marked "Defendants' Exhibit Willcox patent." 954

No. 315,912, to Robert Corscaden, April 14, 1885, the same being marked "Defendants' Exhibit Corscaden patent."

No. 366,333, to Marble & Knapp, July 12, 1887, the same being marked "Defendants' Exhibit Marble and Knapp patent."

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No. 367,576, to G. A. Allen, August 2, 1887, the same being marked "Defendants' Exhibit Allen patent."

No. 368,071, to L. Coes, August 9, 1887, the same being marked "Defendants' Exhibit Coes Patent."

956

No. 403,946, to Meyer & Weck, May 28, 1889, the same being marked "Defendants' Exhibit Meyer & Weck Patent."

No. 424,838, to F. L. Union, April 1, 1890, the same being marked "Defendants' Exhibit First Union Patent."

957 No. 478,654, to E. F. St. John, July 12, 1892, the same being marked "Defendants' Exhibit St. John Patent."

No. 484,823, to E. E. Scrubby, October 25, 1892, the same being marked "Defendants' Exhibit Scrubby Patent."

No. 505,166, to O. E. Meyer, Septem-
958 ber 19, 1893, the same being marked "De-
fendants' Exhibit Meyer Patent."

No. 530,622, to W. D. Scott-Moncrieff, December 11, 1894, the same being marked "Defendants' Exhibit Scott-Moncrieff Patent."

No. 556,594, to F. L. Union, March 17,
959 1896, the same being marked "Defend-
ants' Exhibit Second Union Patent."

No. 268,120, to L. Mouras, November 28, 1882, the same being marked "Defendants' Exhibit Mouras U. S. Patent."

Counsel for defendants also offers in evidence printed copies of the specifications and drawings (Blue Books) of the following British Letters Patent:

No. 232, of January 30, 1860, to Thomas Walker, the same being marked "Defendants' Exhibit Walker British Patent."

No. 2329, September 22, 1864, to 961
Thomas Walker and Thomas Ferdinend Walker, the same being marked "Defendants' Exhibit Walker & Walker British patent."

No. 3203, of October 20, 1868, to Gavin Chapman, the same being marked "Defendants' Exhibit Chapman British Pa- 962
tent."

No. 3562, of November 23, 1868, to Thomas Smith and John Van Norden Bazalgett, the same being marked "Defendants' Exhibit Smith & Bazalgett British Patent."

No. 364,of February 8, 1870, to G. W. 963
Wigner, the same being marked "Defendants' Exhibit Wigner British Patent."

No. 1706, of June 14, 1870, to Bevan George Sloper, the same being marked "Defendants' Exhibit Sloper British
Patent." 964

No. 2760, of October 17, 1871, to James Brough Pow, the same being marked "Defendants' Exhibit Pow British Patent."

No. 7134, of May 16, 1887, to Wilhelm Gurtler, the same being marked "De-

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fendants' Exhibit Gurtler British Patent."

No. 3312, of March 1st, 1890, to Adeney & Parry, the same being marked "Defendants' Exhibit Adeney & Parry British Patent."

966 No. 22,747, of December 30, 1891, to Joseph Tertius Wood, the same being marked "Defendants' Exhibit Wood British Patent."

No. 8671, of May 2, 1894, to Frank B. Candy, the same being marked "Defendants' Exhibit Candy British Patent."

967 No. 21,142, of November 8, 1895, to Cameron & Commins, the same being marked "Defendants' Exhibit Cameron & Commins British Patent of 1895."

No. 23,042, of October 17, 1896, to Cameron, Commin & Martin, the same being marked "Defendants' Exhibit Cameron,
968 Commin & Martin British Patent of 1896."

No. 742, of March 11, 1872, to Denton & Field, the same being marked "Defendants' Exhibit Denton & Field British Patent."

No. 5391, of 1881, December 9, to Wil-
969 liam Robert Lake, the same being maked "Defendants' Exhibit Lake British Patent (a communication from Louis Mouras)."

German patent of Alexander Muller, No. 9792, of December 11, 1878, and the same is marked "Defendants' Exhibit Muller German Patent."

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A translation of the sale is also offered in evidence and marked "Defendant's Exhibit Translation of Muller's German Patent."

Counsel for defendants desires to offer in evidence articles and extracts from various publications, which publications 971 are most of them in libraries and it being not permissible to withdraw them for any length of time, he therefore asks that counsel for complainant consents that the Examiner may transcribe those portions of such articles and publications as are relied upon by defendants, and that the 972 copies may be substituted with the same force and effect as though the originals had been offered in evidence.

A publication entitled "Journal of the Society of Arts, Volume 30 of November 18, 1881, to November 10, 1882, London, Published for the Society by George Bell & Son, 4, 5 & 6 York Street, Covert Garden, 1882. 973 The article referred to commencing on page 532 and entitled "Some Practical Aspects of Recent Investigations on Nitrification, by Robert Warington," the same being marked "Defendants' Exhibit Copy of Warington Article on Nitrification No. 1." 974

Also a publication entitled "Report of the British Association for the Advancement of Science, 54th Annual Meeting held at Montreal in August and September of 1884," published London, 1885, John Murray, Albermarle Street, an ar-

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ticle on page 682, entitled ''On Nitrification by R. Warington,'' the same being marked "Defendant's Exhibit Warington Article on Nitrification No. 2.''

Also a publication entitled ''Minutes
of Proceedings of the Institution of Civil
976 Engineers with other Selected and Abstracted Papers, Vol. LXXXVIII," edited by James Forrest, published by the Institution at London, 25 Great George Street, Westminster, S. W., 1887, an article beginning on page 155, entitled ''Sewage Sludge and its Disposal,'' by
977 William Joseph Dibdin, the portions of said article which are offered in evidence are as follows: The paragraph beginning near the bottom of page 161 and ending in the 6th line of page 162, this extract being marked ''Defendants' Exhibit Extract from Dibdin's Paper.''

978 Also that portion of the same article, under the general head of ''Filtration,'' beginning with the 13th line from the bottom of page 164, and ending with the 4th line from the bottom of said page, the same being marked ''Defendants' Exhibit Second Extract from Dibdin's Pa-
979 per.''

Also a reprint of a report to the London County Council entitled ''Report by the Chemists on the Experiments on the Filtration of Sewage Effluent, during the years 1892-3-4-5'' and printed as a part of the Interim Report of the Commission-

ers appointed in 1898 to inquire and report what methods of treating and disposing of sewage (including any liquid from any factory or manufactory process) may properly be adopted," Vol. 2, Evidence, the same being published in London in 1902, this Report of Dibdin 981
referred to beginning on page 121 of said publication. The same is marked "Defendants' Exhibit Dibdin's Report to the London County Couicil."

Also a copy of a report made by Henry Austin, C. E., Chief Superintending Inspector of the Board of Health, London, 982
published in London in 1857, the portions of this work which defendants' counsel desire to have copied and marked are as follows: The description of the Clifton Union Works and the plan thereof, the same being described on page of said Report. Also the description and plan of 983
the Cheltenham Sewage Works, described on page 32 of said Report. Also the description and plan of the sewage works at Ely, described on page 35 of said report. Also the description and plan of "Proposed Sewage Works," described on page 79, and the conclusions of his report 984
on page 89. These extracts are marked "Defendants' Exhibits Austin's Plans," "Clifton Union Works," "Cheltenham Sewage Works," "Ely Sewage Works," "Proposed Sewage Works" and "Conclusions."

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Also an article from the Journal of the
Society of Arts above mentioned, Volume
46, said article being found on page 165
of said volume, under the heading ''Cor-
respondence,'' and entitled ''Self Purifi-
cation of Sewage," the same being
986 marked ''Defendants' Exhibit Roechling
Article.''

Also from the publication entitled
''Minutes of Proceedings of the Institu-
tion of Civil Engineers, ''Volume 48, page
350, the article entitled ''Mouras Auto-
matic Scavenger,'' and the same is
987 marked ''Defendants' Exhibit Article
Relating to Mouras Automatic Scaven-
ger (No. 1).''

Also Volume 72 of the same publica-
tion, page 359, an article entitled ''The
Theory and Active Working of the Au-
tomatic Scavenger,'' the same being
988 marked ''Defendants' Exhibit Article Re-
lating to Automatic Scavenger (No. 2).''

Also an article from Volume 78 of the
same publication, page 502, an article en-
titled ''Mouras Automatic Scavenger,''
said exhibits being marked ''Defendant's
989 Exhibit Article relating to Mouras Auto-
matic Scavenger (No. 3).''

Also a publication entitled the ''Engi-
neering News,'' published in New York,
under date of April 15, 1892, an article on
page 117 thereof, entitled ''An Automatic
Vault Cleaner,'' and the same is marked

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"Defendants' Exhibit Article Relating to Automatic Vault Cleaner."

Also a paper entitled, "Application of a Reservoir Interceptor made on the Type of Mouras Fose and of a Peat Filter for Sewage in the System of Separate Sewerage by L. Pagliani, Professor of Hygiene and 991
Director of Public Health in Rome, Italy." This article being a paper read before the Seventh International Congress of Hygiene and Demography, held in London, in 1891, and being contained in a volume made up of papers read at said Congress and in the Library of the American Insti- 992
tute of Civil Engineers of New York City. A copy of this article is offered in evidence and marked, "Defendants' Exhibit, Pagliani Article."

Counsel for defendants also offers in evidence a printed pamphlet entitled, "Extracts from the Press on the Scott-Mon- 993
crieff System for the Purification of Sewage," the same containing quotations from various newspapers and periodicals, published in England; the same is marked "Defendants's Exhibit Pamphlet, relating to Scott-Moncrieff System."

Defendant's counsel offers, if it is in- 994
sisted on by counsel for complainant to procure copies of the newspapers and periodicals from which said extracts purport to have been taken.

Also a publication entitled "Journal of the Society of Arts," published in London,

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an article on page 662, entitled "Hurst Pierpoint (Sussex) Sewage," by Charles Wollaston, the same being marked, "Defendants' Exhibit, Wollaston Article."

Also a book by W. Santo-Crimp, entitled "Sewage Disposal Works, A Guide to the
996 Construction of Works for the Prevention of the Pollution by Sewage of the Rivers and Estuaries," published in London, by Charles Griffin & Co., 1890.

An article relating to the Merton Sewage Disposal Works on page 151 of said book, under the heading, "Tanks," the
997 same being marked "Defendants' Exhibit, Description of Tanks of Merton Sewage Disposal Works."

Also in the same work, an article on page, 164, upon the tanks at Chiswick, the same being described on page 165, under the heading, "Treatment." This exhibit is marked, "Defendants' Exhibit, Des-
998 cription of Chiswick Tanks."

Also in the publication, "Minutes of Proceedings of the Institution of Civil Engineers," in Volume 49, pages 180, to 182, an article by Professor H. Tanner, and the same is marked, "Defendants' Exhibit, Tanner Article, relating to Subsi-
999 dence Tanks."

Also in the same publication, Volume 76, of 1884, an article by Santo-Crimp upon the Wandle Valley Main Drainage," and the same is marked, "Defendants' Exhibit, Santo-Crimp's Description of Wandle Valley Main Drainage."

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Also in Volume 79 of the same publication, an article, entitled, "The Burnham Sewerage Works," page 353, and the same is marked, "Defendants' Exhibit Article on Burnham Sewerage Works."

Also in a work by Santo-Crimp above referred to, description of the works of 1001
Friern Barnett, beginning on page 194 thereof, and the same is marked, "Defendants' Exhibit Article on Friern-Barnet Works."

Also from the same publication, a description of the tanks at Wimbledon on page 216, plate 25, and the same is marked, 1002
"Defendants' Exhibit, Description and Plan, Wimbledon Works."

Also the answer to Question 1674, on page 93 of the "Report of the Royal Commission on Sewage Disposal," before referred to, and the same is marked, "Defendants' Exhibit Santo-Crimps Descrip- 1003
tion of Tank Actoin at Wimbledon."

Also an article relating to the tanks at Frankford, Germany, as described by W. H. Lindley, in Volume 46, of the Minutes of Proceedings of the Institute of Civil Engineers, above referred to, pages 392, 393, and the same is marked, "Defendants' 1004
Exhibit, Description of Tanks at Frankfort, Germany.

A publication entitled, "The Sanitary Drainage of Houses and Towns," by George E. Waring, Jr., published in 1876. Grease Trap used by him at Newport,

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Rhode Island, pages 195 and 199. Copies of these pages and sketches, Figures 14 and 16, are introduced in evidence and marked, "Defendants' Exhibit, Waring Grease Traps."

Also a a book entitled, "Sewerage and
1006 Land Drainage by George E. Waring, Jr.," 3rd Edition, New York, D. Van Nostrand Company, London, E. & F. N. Spon, 1891; an article beginning on page 287, entitled, "The Disposal of House Waste," pages 287, 288, 289, 290 and 291 are copied and offered in evidence as "Defendants' Ex-
1007 hibit, copies of pages 287-291, Waring's Book, Sewerage and Land Drainage."

Also a catalogue entitled, "Flush Tank Company, Manufacturers of Automatic Siphons for Intermittent Flush Tanks," 169 La Salle Street, Chicago, Ill., 1892, and the same is marked, "Defendants' Ex-
1008 hibit, Catalogue of Flush Tank Company, Chicago."

Also a publication entitled, "Modern Methods of Sewage Disposal, by George E. Waring, Jr.," published in 1894, pages 216, 218, and the same are copied and marked, "Defendants' Exhibit, Extract from War-
1009 ing's Book on Modern Methods of Sewage Disposal."

Counsel for defendants also offers in evidence, copies of articles published in the Sanitary Engineers, of New York City on May 10th and 17th, 1883, by Edward S. Phillbrick, entitled, and the same are

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marked, "Defendants' Exhibit, Phillbrick Articles."

Also a work entitled, "Sewage Disposal in the United States," by George W. Rafter and M. N. Baker, New York, D. Van Nostrand Company, London; Sampson, Low, Marston & Co., Limited, 1894, Chapt- 1011
er beginning on page 456, entitled, "Broad Irrigation at the Worcester, Massachusetts, State Hospital for the Insane," and the same is marked, "Defendants' Exhibit, Article on Broad Irrigation at the Worcester State Hospital for the Insane."

Also a publication entitled, "19th An- 1012
nual Report of the Massachusetts State Board of Health for the year 1887," a descriptive article relating to the sewage disposal system at Medfield, Mass. A portion of said article is copied and marked, "Defendants' Exhibit, Description of Sewage Disposal System at Medfield." The illus- 1013
trative sketch introduced by the witness Snow is marked, "Page 100, State Board of Health, 1887."

Also description and plans for the sewage disposal plant of Lawrenceville, New Jersey, for the Lawrenceville School, as referred to in the above mentioned publica- 1014
tion of the American Society of Civil Engineers and published February, 1887, the same being marked, "Defendants' Exhibit, Description and Illustration of Lawrenceville School Plant."

Also in the book of the said Rafter and

Baker, before mentioned, a portion of the article relating to "Intermittent Filtration at the Massachusetts School for Feeble Minded," and the same is marked, "Defendants' Exhibit, Extract from Rafter & Baker's Description of Intermittent
1016 Filtration at the Massachusetts School for Feeble Minded."

Also in the volume heretofore referred to entitled, "Interim Report of the Commissioners," &c., Volume 2, Evidence, defendants wish to introduce copies of questions and answers Nos. 1862, 1891, 1892, 1893,
1017 1894, 1927, 1935, 1937, 1938, 1939, 1940, 1959, 1962, 1964, 1968, 1971, 1972, 1973, 1974, 2014, 2015, 2017, 2018, 2019, 2048, 2049, 2059, 2060, 2063, 2064, 2065, 2069, 2070, 2071, 2079, 2080, 2081 and 2158. These questions and answers are copied and the same are marked, "Defendants' Exhibit,
1018 Cameron Testimony before the Royal Sewage Commission."

Defendants' counsel requests that so far as quotations from the various publications referred to have been spread upon the record, that the recopying of the same as separate exhibits may be dispensed with,
1019 said counsel, agreeing however, to print in full any article which may be insisted upon by counsel for complainant.

Adjourned to Saturday, July 17, 1905, 10:30 A. M.

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New York, June 17th, 1905, 10.30 A. M.

Met pursuant to adjournment.

Present, counsel as before.

Examination of Mr. Snow Continued.

Q. 30. Please state from your experience as a sanitary engineer when septic action begins in the treatment of sewage? A. Septic action 1021 begins as soon as the oxygen in the liquid is consumed. It may occur and does occur in most sewers, in many polluted rivers, ponds and pools, in cesspools and in about all kinds of receptacles of sewage, and no practical way is known of preventing it. The process or action is a natural one. It may be retarded or largely post- 1022 poned, but can not be prevented. It may be hastened. Examples of this occurring in tanks have been hereinbefore cited. For instance, the Austin tanks referred to in his report hereinbefore cited, in which there was a heavy scum formed upon the surface and a deposit on the bottom of the tanks. 1023

Gavin Chapman's process, British patent No. 3203 A. D. 1868 utilized septic action in tanks in which the sewage was purposely kept until it became decomposed and in which to hasten the decomposition the temperature was maintained to from 70 to 80 degrees Fahrenheit. For this same purpose of fermenting sewage, British 1024 patent No. 1706, A. D. 1870, was granted to Bevan G. Sloper. Septic action was clearly described in this patent. Especially in the tanks hereinbefore mentioned by me. where scum formed upon the surface, septic action was occurring.

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Q. 31. Would you know how to design a tank so as to prevent septic action occurring? A. No. All the cesspools that I have ever built and all of the sewage tanks I have ever built have promoted septic action. The elements of the Saratoga tank, such as the non-disturbing
1026 inflow and outflow, were employed in the said Austin tanks and in other tanks hereinbefore mentioned by me, and the same have been common in the art of separating solids from the liquid sewage, and in using these elements in an apparatus whose object is to effect a substantial settling out of suspended matters, it is im-
1027 possible to obviate septic action. Were the septic action principle a proprietory one, engineers, in my opinion, would be forced to abandon the use of tanks and appurtenances which have been common in the art for several decades.

Q. 32. Claim 1 of the patent in suit calls for

"The process of purifying sewage which con-
1028 sists in subjecting the sewage under exclusion of air and light and of agitation to the action of anaerobic bacteria until the whole mass of solid organic matter contained therein becomes liquefied and then subjecting the liquid effluent to air and light."

Please state your understanding of the scope of such claim and what, if anything, you find
1029 novel therein over the prior art heretofore referred to by you? A. I understand this claim to be for a process of purifying sewage. This process consists in subjecting the sewage to the action of anaerobic bacteria. This is accomplished under the exclusion of air, light, and agitation. This subjection of the sewage to

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anaerobic bacteria is extended until the whole mass of solid organic matter contained therein becomes liquefied. The liquid is then subjected to air and light.

As I understand this claim, it possesses no elements novel to the art prior to the said claim.
In Alexander Muller's German patent, No. 9792, 1031
of 1878, in Mouras' apparatus as applied in France and Italy, 1883-1891, in Waring's and in Phillbrick's tanks, and Scott-Moncrieff's tank, and in British patent No. 3312, of 1890, to Adeney and Parry, and in Scott-Moncrieff's United States Patent No. 530,622, of 1894, and in Glover's United States patent No. 258,744, of 1882, the 1032
process of purifying the sewage consisted in subjecting the sewage under exclusion of air, light and agitation, to the action of anaerobic bacteria for the purpose of liquefying the solid organic matter contained in the sewage, and then subjecting the liquid effluent to air and light.

In Muller's process the subjection of the sew- 1033
age to anaerobic bacteria for the purpose of liquefying the solids, was accomplished in basins which were made large to prevent agitation of the sewage, it being specified that they should have a capacity of a full day's output of sewage and be provided with means for its continuous admission and discharge. The sewage was under 1034
the exclusion of air and light by means of a floating top cover of scum or straw, so as to retard cooling and evaporation.

The effluent from the tanks went to filters where it was exposed necessarily to air and light. This process, therefore, consisted of all the elements of said claim.

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Mouras' apparatus, as hereinbefore mentioned by me, comprised an air-tight tank with a trapped inlet and outlet, in which the solids were liquefied by what was thought and described as anaerobic bacteria, so that this tank comprised the first part of the said claim, it being an apparatus
1036 to liquefy solids under the exclusion of air, light and agitation, the exclusion of agitation in the tank being accomplished by a submerged inlet and outlet. The application of this apparatus to the purification of sewage at Logelback, as hereinbefore described, where the sewage was distributed over ground for irrigation, and in Italy by
1037 Pagliani, where Mouras' tank was connected with a filter on to which the sewage was flowed, involved the second part of the above claim; that is, the subjecting of the liquid effluent to air and light.

In Waring's and Phillbrick's tanks, hereinbefore mentioned, the liquefying bacterial action
1038 was intentionally obtained in the first compartment of the apparatus, under exclusion of air, light and agitation, the tank being covered over and made air-tight, but provided with special ventilating pipes which caused air to move over the surface of the liquid and scum in the tank. The exclusion of air and light, therefore, was ef-
1039 fected by the scum which formed on the surface of the tank. It is stated in the patent in suit (line 20, page 2).

"Brown scum begins to form at the top and eventually becomes two or three inches thick and served as an air-tight cover for the sewage below."

The non-agitation of the sewage in these tanks

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was purposely accomplished by means of a submerged inlet and outlet pipe. Therefore these tanks involved the first part of the said claim and where these tanks were used in connection with the subsequent disposal of the effluent upon filters or the ground, or into a river, or other body
of water, the second part of the above claim was 1041
intentionally involved, namely, the completing of the purification process by subjecting the liquid effluent to air and light.

Scott-Moncrieff's cultivating filter comprised the intentional use of anaerobic bacteria for the purpose of liquefying the solids in the sewage and
this was actually accomplished, as hereinbefore 1042
explained. This liquefaction was accomplished in the tank in the bottom of which there was a chamber arranged for the purpose of delivering sewage so as not to cause agitation and the exclusion of light and air was effected by a covering of filtering material. In this tank so covered
there was an arrangement for introducing air, at 1043
times desirable, but the use of this was optional and did not and could not prevent anarebic liquefaction of the sewage solids. Therefore this tank comprised the first part of the claim and the last part, that is, the subjecting the liquid effluent to air and light was accomplished in the nitrifying
trenches, in which the sewage was exposed nec- 1044
essarily and intentionally to air and light, or where these were not used, the effluent was exposed to air and light as it flowed out of the tank at the various openings provided in its side.

The Adeney and Parry British patent, 3312 of 1890, comprises the intentional utilization of

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liquefying organisms to destroy the solid matters in sewage. In the third method described in said patent hereinbefore particularly mentioned, the destruction of organic matter in the subsidence or incubation chamber, can only be through the agency of organisms more distinctly of the ana-
1046 erobic species. No chemicals are used in this third method. Only the natural liquefaction resulting from the retention of the sewage in the tank is embraced and provided for. Clearly, therefore, the organism intentionally utilized therein are the anaerobic kind. There is nothing said in said patent about exclusion of air and
1047 light, but it is stated therein that the sewage should remain in the tank long enough to be treated, therefore I conclude that the tank would be of such size as to promote subsidence to the best advantage and that would necessarily involve the formation of deposits and surface scum under the exclusion of agitation, which, under the
1048 terms of the patent in suit, would comprise an air-tight cover. Therefore the process involves the first part of the claim, that is, the exclusion of air, light and agitation in the process of subjecting the sewage to the action of anaerobic bacteria for the purpose of liquefying the solid matters contained therein. The rest of the said
1049 claim, that is, the subjecting of the liquid effluent to air and light, is accomplished in the said Adeney patent which states that the sewage may be filtered and aerated at any of the stages of the process. But it is especially provided that the effluent from the subsidence and incubation tank shall flow to a filter.

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I have cited Mr. Glover's patent because of what I know of the inventor's purpose. The tanks of his patent, hereinbefore mentioned, were to be operated the same as he operated the cesspool in his back yard, hereinbefore described by me, and that method of operation would necessarily in-
volve what is now known as septic action. Scum 1051
would have formed on the surface of the tank, as in his cesspool, and deposit would have occurred on the bottom. The drawing of said patent shows the liquid flowing out of the last tank over a weir and thence it goes either for subsequent treatment on to the ground filter, or
into the river, thus exposing the effluent for final 1052
purification to air and light. The formation of surface scum embodies the exclusion of air, light and agitation mentioned in said claim. The decomposition known to take place in a cesspool would occur to some extent, and I have heard the inventor claim that his apparatus would as effectually destroy the organic matter as did his
cesspool. All of which leads me to conclude that 1053
his process comprises a prior use of the first claim of the patent in suit.

Adjourned to Monday, June 19, 1905, 10.30 A. M.

New York, June 19th, 1905, 10:30 A. M.

Met pursuant to adjournment. 1054

Present, Counsel, as before.

Direct Examination of Mr. Snow Continued.

Q. 33. Claim 2 of the patent in suit calls for "The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow, from light, air and agitation until

a mass of micro-organisms has been developed of a character and a quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, and then subjecting the said pool under exclusion of light and air and under a non-disturbing inflow and outflow to the liquefying action of the so-cultivated micro-organisms until the solid organic
1056 matter contained in the flowing sewage is dissolved.''

Please state your understanding of the scope of such claim and what, if anything, you find novel therein over the prior art heretofore referred to by you? A. I understand this claim explains the process of liquefaction mentioned in the first claim.
1057 While the second claim sets forth various steps in the liquefying process, the whole claim means, as I understand it, what is meant by the first claim without the subsequent subjection of the liquid effluent to air and light. The various steps are divided naturally into two parts, the first showing the way of cultivating the liquefying organisms, and the second, showing the manner of sustaining
1058 the action of these liquefying organisms to dissolve the solid organic matter of the flowing sewage.

The first part consists of, first, secluding a pool of sewage from light, air and agitation; second, said pool having a non-disturbing inflow and outflow; third, said seculsion being continued until a mass of micro-organisms has been developed of a
1059 character and quantity sufficient to liquefy the solids of the flowing sewage; fourth, it being important to note that the claim states that "the inflow serving to sustain the micro-organisms." The second part consists of then subjecting the said pool—under exclusion of light and air and under a non-disturbing inflow and outflow—to a continu-

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ation of the liquefying action of the so cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved."

With this understanding of the scope of the claim, I find nothing novel therein over the prior art heretofore referred to by me. The claim covers
nothing more, as I understand it, than the natural 1061
process which was carried out in the Muller, Mouras, Waring, Phillbrick, Glover, Adeney and Scott-Moncrieff tanks. The process covered by this claim must of necessity be the process carried out in the said tanks. In Alexander Muller's German patent, No. 9792 of 1878, a pool sewage was se-
cluded from light and air in tanks which were to 1062
be of sufficient capacity for receiving a full day's output, the top covering of floating straw, chaff or scum, so as to retard cooling and evaporation, forming the covering which secluded the pool of sewage from light and air, said pool having a non-disturbing inflow and outflow, else the process for which the patent was granted could not have been
accomplished. The specific form of the inflow and 1063
outflow was not described in said patent, neither is it described in the said claim of said patent in suit. The construction of the apparatus of the said Muller patent,

"The mechanical and structural arrangement
required in carrying out this process are ex- 1064
tremely simple. They consist of three or four basins (or baths) of at least one metre's depth for the digestion and defication of the waste liquid. Altogether they should have a sufficient capacity for receiving a full day's output in waste liquid, "and be provided with means for its continuous admission and discharge."

This providing a tank capacity equal to a full

1065 day's flow in itself forms an increased area of flow
which would diminish the velocity thereof so very
considerably as to unavoidably constitute a non-
disturbing inflow and outflow from the sewage
pool. This secluding of the sewage from light and
air under a non-disturbing inflow and outflow in
1066 the said Muller patent was extended purposely un-
til the liquefying organisms were methodically cul-
tivated. This being accomplished while the sewage
was continuously admitted and discharged from
the pool, thus the inflow serving to sustain the
micro-organisms, and the process was then con-
tinued until the organic matters contained in the
flowing sewage were dissolved.

1067 "The methodical cultivation of those small
'leaven-like' organisms to the viability of which
modern science has traced the so-called 'self-
unmixing' processes, namely, acidification, fer-
mentation, putrefaction, decay or the like, in ac-
cordance with rules of physiology, with a view
to bringing them into requisition in the task of
precipitating out the liquid waste substances or
bringing about their complete mineralization."

1068 In the Mouras, apparatus, as hereinbefore men-
tioned, and described by me, the tank was covered
over and constructed air and light tight, and the
submerged inlet and outlet pipe comprised a non-
disturbing inflow and outflow arrangement, thus
obviating agitation. Scum formed upon the sur-
face and the expressed object of the apparatus was
1069 to promote the growth of and the development to a
sufficient extent of the micro-organisms sufficient
to liqefy the solids of the flowing sewage. Mouras'
tank was designed to operate upon the continuous
principle, sewage flowing in and out at any or all
times. It was observed, in reference to the Mouras
tank, in an article hereinbefore quoted,

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"That the more water is passed into the cesspool the more rapid and complete is the destruction of the suspended matter, and it remains to be seen what quantity of water can most advantageously be used to give the best results on a large scale."

This was a recognition of a relation existing between the inflowing sewage and the sustaining of 1071
the micro-organisms which liquefied the solid matter.

In Mouras' said apparatus, the second part of the said claim of the patent in suit was accomplished, it being the intention of the Mouras apparatus to subject the sewage, under exclusion of air, light and agitation, to the liquefying organisms so culti- 1072
vated until the solid organic matter contained therein was dissolved.

In Waring and Phillbrick's tanks, hereinbefore mentioned, the liquefying organisms were intentionally cultivated in the same manner as described in said claim No. 2 of the patent in suit; that is, the submerged inlet and outlet pipes comprise a
non-disturbing inflow and outflow, and the exclu- 1073
sion of light and air was accomplished by the formation of the scum on the surface of the water in the tanks, and the object of secluding this pool of sewage in this way was to promote the activities of those agencies which were known and observed under the conditions provided in these tanks to ac-
complish the dissolving of the organic matters in 1074
the sewage. These tanks were designed to operate on the continuous principle.

Recess.

In British patent, No. 3312 of 1890, to Adeney and Parry, I conclude from the reasons set forth in my answer to Q. 32, that the special way of cul-

1075 tivating the liquefying organisms in the third method described in said British patent, comprise the same process described in the said claim of the patent in suit and that the manner of sustaining the action of the liquefying organism to dissolve the solid organic matters contained in the sewage
1076 are the same in both the said British patent in the third method described therein, and in the second claim of the patent in suit.

In United States patent, No. 530,662, December 11, 1894, to Scott-Moncrieff, has for its object the process of liquefying solid matters in sewage which consists in secluding a pool of sewage from light,
1077 air and agitation, as described in my answer to Q. 32. The non-disturbing inflow being provided by the inlet chamber which widens out into the cultivating filter tank, and the non-disturbing outflow being provided by the series of openings on the side of the said filter tank. The operation of this tank being on the continuous principle, thereby furnishing by the inflow of the sewage the necessary food
1078 supply to sustain the liquefying organisms. And this process of liquefaction being continued, as in the said second claim of the patent in suit, until the solid organic matter contained in the flowing sewage is dissolved.

Q. 34. Claim 3 of the patent in suit calls for, "The process of liquefying the solid matter
1079 contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow, from light, air and agitation until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, then subjecting the said pool under a non-disturbing inflow and outflow and under exclusion of

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light and air to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved, and then subjecting the liquid outflow to an aerating operation."

Please state if you understand the scope of such claim, and what if anything, you find novel therein over the prior art referred to by you? A. This 1081
claim reads exactly the same, word for word, as Claim 2 of the patent, with the words added "and then subjecting the liquid outflow to an aerating operation."

I have already shown in my answer to Q. 32 in respect to the first claim of the patent in suit, that the aerating operation as applied to the liquid out- 1082
flow was common to the application of the Mouras tanks in Italy and at Logelback, France; and also provided for in Alexander Muller's German patent, No. 9792 of 1878; and also to the Waring and Phillbrick tanks when used in connection with the subsequent disposal of the effluent upon filters or the ground, or into a river or other body of water. 1083

Scott-Moncrieff's cultivating filter, U. S. patent, No. 530,622, of 1894, also provided for aeration of the liquid effluent, and so also did British patent, No. 3312, of 1890, to Adeney & Parry.

All of which cititations, excluding the subjecting the liquid outflow to an aerating operation, I have cited as containing the elements of Claim 2, 1084
of the patent in suit, as I understand them, and all of which, including besides the elements of Claim 2, the subjecting the liquid outflow to an aerating operation, I cite as embodying and utilizing the elements of said Claim 3 of the patent in suit, as I understand it.

1085 F. Herbert Snow.

The process of aerating effluents from tanks is very old in the art, and I have hereinbefore made numerous mentions and descriptions of such use in the art. It is practically universal in the art of sewage purification where a tank is used for almost any purpose whatever, to aerate the effluent
1086 therefrom. This has been accomplished in practice in a great variety of ways, and there have been numerous patents issued for special devices, a few of which I have hereinbefore mentioned. Since Franklin's experiments in 1868, without any departure from the principle, the idea has obtained in practice that the more thoroughly sewage is aerated
1087 the more rapidly and completely it is purified. This principle has been maintained by Franklin, Warington, the Massachusetts State Board of Health, Dibdin, and others.

Mr. Cameron himself among the number. In this connection I will refer to the aeration of tank effluent hereinbefore described by me at the Cheltenham Sewage Works, and the proposed
1088 sewage works mentioned in Mr. Austin's Report; in British patent No. 232, of 1860, to Thomas Walker, British patent, No. 2329, of 1864, to Thomas Walker and another, and in British patent No. 3562, of 1868, to Thomas Smith and another; and in British patent 364, of 1870, to George W. Wigner; the effluent was intentionally
1089 subjected to an aerating operation. And in connection with tanks which have been in use, hereinbefore described by me, those at the Croyden Sewage Farm, in 1861; at Aldershot Camp Farm, 1864; at Hurst Pierpoint, 1877; at Chiswick, 1878; and at the Burnham Sewerage Works, 1885; at Friern Barnet, 1887; all of which are in England.

provided special arrangements for the aerating of the effluent from tanks. British patent No. 2760 of 1871, to James Pow, is for a special apparatus for aerating tank effluent; so also was British patent No. 8671, of 1894, to Frank P. Candy; so also were the United States patents No. 366,333, of 1887, to Albert T. Marble and another; 1091
No. 368,078, of 1887, to Loring Coes; patent No. 484,823, of 1892, to E. E. Scrubby, special attention being called to this patent; and U. S. patent No. 556,596, of 1896, to Frank L. Union, which provide for the aeration of tank effluents by special devices designed therefor. These are some instances only of a vast number which might be 1092
cited.

I find therefore no novelty in claim 3 of the patent in suit.

Q. 35. Claim 4 of the patent in suit calls for:

"The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow from light, air, and agitation until 1093
a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, then subjecting said pool under a non-disturbing inflow and outflow and under exclusion of light and air to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved, 1094
then subjecting the liquid outflow to an aerating operation, and then to a filtering operation."

Please state if you understand the scope of such claim, and what, if anything, you find novel therein over the prior art referred to by you? A. This claim reads exactly the same, word for word, as claim 3 of the patent with the words added:

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"and then to a filtering operation."

As I understand this claim, I do not find anything novel therein over the prior art hereinbefore referred to by me. The Mouras apparatus as applied in Italy and at Logelback, France, embodied all the elements of said claim 4 of the pa-
1096 tent, as I understand the claim. So also did the apparatus of the Muller German patent, No. 9792, of 1878; so also did the Waring and Phillbrick apparatus, and Scott-Moncrief's cultivating filter, as used in England, and as described in U. S. patent, No. 530,622, of 1894. So also did British patent, No. 3312, of 1890, to Adeney & Parry
1097 embody the elements of claim 4 of the patent in suit, as I understand it.

So also do other tanks, hereinbefore mentioned by me as examples of actual use, embody in practice the elements of said Claim 4.

Q. 36. Claim 21 of the patent in suit, calls for,

"The process of liquefying the solid matter contained in sewage, which consist in secluding a pool
1098 of sewage having a non-disturbing inflow and outflow from light, air and agitation until a thick scum is formed on the surface thereof and a mass of micro-organisms has been developed of a character and quanitity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, and then subjecting said pool under the cover of said scum and under a non-disturbing inflow and outflow of the liquefy-
1099 ing action of the so-cultivated micro-organisms until the solid matter contained in the flowing sewage is dissolved."

Please state if you understand the scope of such claim, and what, if anything, you find novel therein over the prior art referred to by you? A. This claim is the same, word for word, as Claim 2 of the patent, with the exception that scum formed on

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the surface of the sewage is mentioned. In the
fifth line of Claim 21, after the word, "until," the
following words are added; "a thick scum is form-
ed on the surface thereof and," while in Claim 2,
these words are not used, the mass of organisms
developed by the sewage pool in Claim 2, not
necessarily being accompanied by the formation of 1101
scum in said Claim 2, but in said Claim 21, the pool
of sewage is secluded as above described in the
claim, from light, air and agitation, until a thick
scum is formed on the surface thereof and a mass
of micro-organisms has been developed.

Again, in the 11th line of said Claim 21, the
words, "the cover of said scum," are used after the 1102
word, "under" in said line, so as to read, with
what precedes and follows it, "and then subjecting
the said pool under the cover of said scum and un-
der a non-disturbing inflow and outflow," while in
Claim 2, after the word, "under" were used the
words, "exclusion of light and air," so that that
part of Claim 2, read "and then subjecting said
pool under exclusion of light and air and under a 1103
non-disturbing inflow and outflow." So, "the cov-
er of the scum," in Claim 21 are the words substi-
tuted for the words "exclusion of light and air,"
in Claim 2. Claim 21, therefore, includes the op-
eration of the process when a thick scum is formed
on the surface, under the cover of which the pool
is subjected, as described, to the liquefying action. 1104
As I understand this claim, it does not embody
anything novel therein, over the prior art herein-
before referred to by me in my answer to Q. 33. In
the cases cited in that answer, scum did form and
floated upon the surface of the liquid. From my
own knowledge, this scum which forms upon the

1105 surface of a sewage pool, may vary in thickness and extent, but this irregularity does not apparently diminish to an appreciable extent the liquefying action. A large per centage of the solid particles in suspension in sewage upon entering a tank will settle at the bottom until by the formation of
1106 gases they are buoyed up to the surface where the gases are liberated and the solid matters, perhaps dividing into smaller particles, tend to settle again. While on the bottom, these particles are subjected to the seclusion of light and air and agitation, naturally, by the fact of a sufficient depth of water being above them to accomplish this exclusion of light, air and agitation. While in this condition,
1107 the liquefying organisms are developed and forming gases, through their activities, raise the solids, as hereinbefore mentioned, to the surface of the sewage, where some of them will remain and in time a mass of floating scum accumulates on the surface. This scum, by its absence, can not prevent liquefying action occuring on the bottom of the tank un-
1108 der exclusion of light, air and agitation, by reason of the water above it, as previously described. On the other hand, the formation of the scum is not known to assist, to any appreciable extent, the liquefying action going on in the solids precipitated on the bottom of the tank. I therefore consider Claim 21, as I understand it, to contain no novelty
1109 therein over the prior art hereinbefore referred to by me.

Q. 37. Please compare claim 7 of the patent in suit with defendants' structure as illustrated in the exhibit of the Saratoga Plant, and state whether or not there is present in defendant's system the elements of the said seventh claim? A. Defendants'

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structure does not have an outlet comprising a con-
duit having a longitudinal slot open across the
greater part of the width of the tank, but has a
series of openings in the wall of said tank, opening
into a conduit or chamber exterior to the tank. In
the patent in suit, the conduit is in the tank ex-
tending in the tank the greater part of its width, 1111
said conduit being marked or numbered 10 on the
drawing, and from this conduit in the tank two
pipes, 17, extend through the wall, connecting with
a conduit or chamber on the outside of the tank.

Q 38. Please consider Claim 7, in connection
with the prior art, and state your opinion as to the
validity of such claim over the prior art, giving 1112
your reasons for your opinion?

Adjourned to Tuesday, June 20, 1905, 10:30 A.M.

New York, June 20th, 1905, 10:30 A. M.

Met pursuant to adjournment.

Present, Counsel, as before and also Ephraim Banning, Esq., for defendants.

Direct Examination of Mr. Snow Continued:

A. to Q. 38. Said Claim 7 is as follows: 1113

"In an apparatus for the purification of sewage, the combination of a septic tank, and an outlet therefor disposed above the bottom and below the normal water-level thereof, said outlet comprising a conduit having a longitudinal slot open across the greater part of the width of the tank."

The object of the outlet conduit disposed above
the bottom and below the normal water level of the 1114
tank and extending across the greater width of the
tank, is to collect the liquid in the tank so as not to
disturb the top layers of the liquid or the bottom
layers, which top and bottom layers contain the
floating matters and the deposits respectively. Said
outlet thus removes the water from mid-depth, or

1115 thereabouts, and does not disturb the rest of the contents of the tank. Outlets to serve this same purpose have been provided in tanks and used in the art for many years. In this connection I will refer to the Cheltenham tanks, described in page 32 of Mr. Austin's report, hereinbefore mentioned
1116 by me, in which tanks there are provided outlet chambers or conduits located within the tanks and extending nearly the whole width thereof, having perforated holes in their walls through which the effluent is conducted out of the tanks below the top and above the bottom for the purpose served by the outlet of said Claim 7 of the patent.

1117 Mr. Austin's proposed tank, hereinbefore mentioned, provides for an outlet conduit extending the width of the tank and above the bottom and below the top, whose object is the same as the object of the said outlet in said Claim 7.

In British patent, No. 2329, of 1864, to Thomas Walker and another there is provided an outlet conduit or chamber, extending the whole width of
1118 the tank and being disposed above the bottom and below the top, said outlet conduit being provided with a slot, the whole width of the conduit, whose object is the same as the object of the outlet conduit in said Claim 7 of the patent.

In British patent, No. 3562, of 1868, to Thomas Smith and another, there is provided an outlet con-
1119 duit, comprising a conduit having a slot or opening extending the entire width of the tank and being disposed below the top and above the bottom of the normal water level thereof, whose object is the same as the object of the outlet in said Claim 7.

The tanks at Merton, described in Santo-Crimp's book, hereinbefore mentioned by me, is provided

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with a series of openings through the wall of the outlet end of the tank, said openings extending the whole width of the tank, and from the top to the bottom thereof, whose object is the same as the object of the outlet conduit of said claim of the patent.

In the Wandle Valley tanks, described in Volume 1121
76 of the Minutes of Proceedings of Civil Engineers, hereinbefore mentioned by me, there is provided an outward conduit or chamber extending the whole width of the tank and having a series of openings in its walls extending the whole width thereof, some of them being above the bottom and below the top of the normal water level in the tank,
said outlet conduit having the same object as the 1122
object of the outlet conduit in said claim of the patent.

British patent, No. 2760, of 1871, to James B. Pow, provides an outlet conduit extending nearly the whole width of the tank and disposed within the same, said conduit having an opening in its bottom for the entire length of the conduit, being dis- 1123
posed below the top and above the bottom of the water level of the tanks, the object of said outlet conduit being the same as the object of the said conduit of said Claim 7 of the patent in suit.

British patent, No. 7134, to Wilhelm Gurtler, 1887, provides for an outlet chamber located with-
in the tank and extending for a part of the width of 1124
said tank, and having a series of apertures within its sides and bottom, disposed above the bottom and below the top of the water level of the tank, the object of said outlet chamber being the same as the object of the outlet conduit of said claim in the patent in suit.

United States Patent, No. 505,166 of September 19, 1893, to Oluf E. Meyer, provides for an outlet conduit extending the whole width of the tank and disposed in the tank below the top and above the bottom of the normal water level thereof, having in the whole length thereof an opening or slot, the
1126 said outlet conduit having the same object and serving the same purpose as the outlet conduit of said claim of said patent in suit.

United States patent, No. 580,793, of April 13th, 1897, to G. D. Mitchell, provides for the proper drawing off of the effluent from one tank to another by any suitable arrangement of pipes extending
1127 over the full width of the tank, or any portion thereof, and the drawing of said patent shows an outlet chamber 15, disposed in the tank and having a slot in said conduit below the top and above the bottom of the tank, which arrangement may extend the entire width of the tank, said outlet comprising a conduit having a longitudinal slot open across the greater part of the width of the tank and serv-
1128 ing the same purpose and having the same object as the outlet conduit in said Claim 7 of the patent in suit. The application for the said Mitchell patent was filed March 26, 1896.

The tank at the Worcester State Hospital, described in Rafter & Baker's book, hereinbefore mentioned, has an outlet chamber connecting with the
1129 main tank by a series of openings in the dividing wall, said openings being below the top and above the bottom of the tank and extending the whole width, or nearly the whole width of the tank. These openings in the wall serving the same purpose as the outlet conduit of Claim 7 of the patent in suit.

Q. 39. Please compare claim 8 of the patent in suit with defendants' structure as illustrated in the exhibit of the Saratoga plant, and state whether or not there is present in defendants' system the elements of the said eighth claim? A. Claim 8 is as follows:

"In an apparatus for the purification of sewage, the combination of a septic tank having an outlet 1131
consisting of a pipe extending acros sthe greater part of the width of the tank and disposed above the bottom and below the normal water level thereof, said pipe having an opening in its wall throughout its length for admitting the effluent."

This claim is like claim 7, but provides that the outlet conduit shall be a pipe disposed above the bottom and below the normal water level of 1132
the tank and having an opening in its wall throughout its length for admitting the effluent. Defendant's plant does not infringe said claim 8, as I understand it, because there is no pipe arranged and constructed as stated in said claim 8. If, however, said claim 8 is construed so broadly as to cover defendants' construction, then it must 1133
be anticipated, as I understand said eighth claim, in the same references which I have cited as anticipating claim 7 of the patent in suit.

Q. 40. Please consider claim 8 in connection with the prior art, and state your opinion as to the validity of such claim over the prior art, giving your reasons for your opinion? A. The ob- 1134
ject of the pipe in claim 8 is the same as the object of the conduit in claim 7, claim 7 being broader in that it does not specify that the conduit shall be a pipe. It does not seem to me that the substituting of a pipe having an opening in its wall throughout its length for admitting the

1135 effluent, in the place of a conduit having a longitudinal slot open across the greater part of the width of the tank for admitting the effluent, comprises an invention, since both are disposed in the tank in the same way and both have the same object and serve the same purpose. Therefore the
1136 references which I have cited in the prior art with respect to claim 7 are equally applicable to said claim 8 as I understand it.

Q. 41. Please compare claim 5 of the patent in suit with defendants' structure, as illustrated in the exhibit of the Saratoga Plant, and state whether or not there is present in defendants'
1137 system the elements of the said fifth claim? And also consider said claim in connection with the prior art? A. The fifth claim is for

> "In an apparatus for the purification of sewage, the combination of a septic tank having an outlet disposed above the bottom and below the normal water level of the tank, and open across the greater part of the width thereof, and an aerator
> 1138 connected with said outlet."

This is a broad apparatus claim. So far as the mechanical features of the claim are concerned, the purpose of the outlet arranged as set forth is to give a non-disturbing outflow along the width of the tank. And the aerator is for the purpose of aerating the effluent. The aerator in
1139 the patent in suit "is divided into a suitable number of compartments 64. The effluent passes into the first of these compartments, and when this is filled it passes out through an opening in the top into a slightly sloping surface 65, down which it flows in thin films until it falls into the next compartment 64, this operation being re-

peated until it arrives at the last compartment, whence it may, if desired, be conveyed through pipes 66 to a filter or filters for further treatment. It will be seen that as the effluent passes over the inclined surface 65 it will be exposed to the action of the air and so aerated. Instead of employing the form of aerator above described an 1141
overhanging lip or lips may be provided, over which the effluent falls in a thin film or films exposed on both sides to the air.'' And on line 89 of page 1 of the patent:

"The liquefied sewage as it leaves the septic pool has a slight odor, so slight, however, that it can not be noticed at a distance of a yard or two, and to relieve it of this slight odor it is subjected to an 1142
aerating operation."

The aerator in defendants' plant is of entire different form and construction. It is composed of a weir such as has been used in the art for a great many years, said weir being formed by a vertical plate over which the sewage flows in a thin sheet and is aerated; from thence it is con- 1143
ducted by a pipe some distance to an outlet chamber and thence through another pipe to a second aerator of special design, comprising a rising pipe discharging the effluent from its top over a metal plate arranged in umbrella fashion about the rising pipe, said plates being perforated and over which and through which the liquid flows 1144
and is aerated.

The object of the aeration in the patent in suit is stated to be "to relieve the effluent of the slight odor which the liquefied sewage has as it leaves the septic pool.'' The object of the aeration in defendants' plant is not to relieve the sewage of

odors, but to promote the saturation of the sewage with oxygen in order to aid the work of nitrification in the filter. The aeration in defendant's plant would be dispensed with were there no filters in connection with the plant, and therefore it is important in understanding said defendants'
1146 plant to associate the aerating device with the filters as being as much an appurtenance to the filters as are the dosing tank, gates and distributing carriers. But in the patent in suit the aerating device is at the septic tank and a part of it, for as above quoted it is stated (line 51, page 3):

"This operation being repeated until it arrives at the last compartment, whence it may, if desired, be
1147 conveyed through pipe 66 to a filter or filters for further treatment."

I wish to lay special emphasis on this difference in arrangement, location and object of aeration in the patent in suit and in defendants' plant. In the patent in suit the aerator is a part of the tank apparatus and completes the first stage of
1148 the treatment of the sewage, its further treatment, if desired, being on filters, &c. In defendants' plant the aeration is an adjunct of the filter and not of the tank treatment.

So far as the construction and disposition of the outlet in said claim 5 is concerned, and the combining therein of means of aeration, the ob-
1149 ject and the results produced are precisely the same, whether these features are combined with a septic tank or settling tank, and these features are old in the patents cited in connection with claim 7, and the combining of these old features with any sort of a tank would not require invention, especially as a septic tank with a non-dis-

turbing outlet is old, as in Mouras' tanks, hereinbefore referred to, and Waring and Phillbrick. Furthermore, all sorts of aerators have been devised and used for aerating the effluent from sewage tanks, and also aerators combined with tanks having "an outlet disposed above the bottom and below the normal water level of the tank, 1151
and open across the greater part of the width thereof." In this connection I will refer to British patent No. 3562, of 1868, to Thomas Smith and another, in which the sewage from each tank passes through an outlet which extends across the greater part of the width of said tank and is below the normal water level of such tank and 1152
flows over a weir into what is called in the patent a "tumbling bay."

British patent No. 2760, of 1871, to James B. Pow, provides for an outlet disposed above the bottom and below the normal water level of the tank, and open across the greater part of the width thereof, and an aerator connected with the 1153
said outlet through which outlet the effluent passes, flowing over the weir where it is aerated in the form of spray by three successive falls of the effluent, accomplished by a special device arranged therefor.

United States patent No. 505,166, September 19, 1893, to Oluf E. Meyer, comprises an outlet 1154
arranged in the same manner as described in claim 5 of the patent in suit, and an aerator connected with said outlet, said aerator comprising an apparatus in which the sewage is aerated and filtered in alternate compartments, provided therefor.

1155

Q. 42. Please compare claim 6 of the patent
in suit with the defendants' plan of sewage dis-
posal system, and state whether or not you find
in the latter the elements of said claim, and also
consider said claim with reference to the prior
art and state your opinion as to its novelty, giv-
1156 ing reasons for such opinion. A. I find that said
claim contains as an element a settling tank, in
addition to the septic tank constructed as set
forth in said claim. The defendants' plant does
not contain a settling tank apart from the main
tank itself. Therefore defendants' tank is de-
signed to take everything contained in the sew-
1157 age, while in the claim 6 of the patent in suit
there are two tanks provided, in the first or set-
tling tank of which, as elsewhere explained in
the patent, the grit and other solid matters are
allowed to settle. So far as the claim for the
catch-pit is concerned, such pits have been com-
mon in the prior art for many years. Numerous
instances having been hereinbefore mentioned by
1158 me. Good illustrations of the use of catch-pits
or settling tanks for the purpose explained in
said patent in suit are afforded in British patent
No. 2329 of 1864 to Thomas Walker and another,
and the Wigner U. S. patent 108,664.

Furthermore, Mouras U. S. patent 268,120 con-
1159 tains a grit or settling chamber in combination
with a septic tank having an outlet disposed
above the bottom and below the normal water
level of the tank, but this outlet, as shown in the
said drawing of said Mouras patent, was not open
across the greater part of the width of the tank.
To widen the outlet according to the size of the
tank and for the purpose for which an outlet is

 1160

widened in connection with settling tanks, could not possibly require any inventive skill, as I understand the prior art.

In view of the universality of the use of settling tanks or catch-pits for the purpose explained in said patent in connection with the use of main tanks, I consider that the art cited by me 1161
in connection with claim 7 of the patent in suit is also anticipatory of claim 6.

Q. 43. Claims 11 and 12 of the patent in suit are as follows:

"11. In an apparatus for purifying sewage, the combination of a septic tank, an inlet disposed above the bottom of the tank and below the normal water level thereof and occupying the greater part 1162
of the width of said tank, and an outlet extending across the greater part of the width of said tank and disposed above the bottom of the tank and below the normal water level thereof.

"12. In an apparatus for purifying sewage, the combination of a septic tank, an inlet occupying the greater part of the width of said tank, and an outlet extending across the greater part of the width of the tank and disposed above the bottom 1163
of the tank and below the normal water level thereof, said outlet comprising a pipe having a longitudinal slot therein extending the greater part of its length."

Please compare these claims with the prior art of which you have knowledge and state what, if any, novelty you find in said claims? A. So far as claim 11 is concerned, it is similar to claim 5, 1164
leaving out aeration, but adding the feature of the wide non-disturbing inlet. This inlet disposed above the bottom of the tank and below the normal water level thereof, and occupying the greater part of the width of the tank, is old in the art.

Adjourned to Wednesday, June 21, 1905, 1:30 P. M.

1165 F. HERBERT SNOW.

New York, June 21, 1905, 1:30 P. M.

Met pursuant to adjournment.

Present, counsel as before.

Examination of Mr. Snow Continued.

(Witness continues his answer to Q. 43.)

In this connection I will refer to tanks herein-
1166 before mentioned by me. The Clifton Union
Works, described in Mr. Austin's Report, com-
prised tanks having an inlet disposed above the
bottom of the tank and below the normal water
level thereof, and occupying the greater part of
the width of said tank, said inlet consisting of a
conduit or chamber extending the entire width
1167 of the tank, disposed on the outside of it and
having a series of slots or apertures through
the wall into the tank, delivering the sewage into
the tank below the top and above the bottom
thereof for its entire width. The proposed Austin
tank is shown both in the sketch in said Austin
Report, and also by the description hereinbefore
1168 quoted by me from page 79 of said Report. It
provides for an inlet disposed above the bottom
of the tank and below the normal water level
thereof and occupying the greater part of the
width of said tank, consisting of a wall 'with bas-
ket work and preforated boards in the middle,
allowing the water to pass through only at a cer-
1169 tain depth beneath the surface. And an outlet
evtending across the greater part of the width
of said tank and disposed above the bottom of
the tank and below the normal water level
thereof, consisting of strainers through which the
sewage would pass laterally, its object being to
allow the surface water only to pass away, and
promote deposits in the tank.

 1170

British patent No. 2329, of 1864, to Thomas Walker and another, provides a tank provided with an inlet disposed above the bottom of the tank and below the normal water level thereof, said inlet consisting of a sewer or delivery conduit deposed on the outside of the tank and having several openings through the wall of said 1171
tank, said openings being below the top and above the bottom thereof. And said tank is provided with an outlet extending across the greater part of the width of said tank and disposed above the bottom of the tank and below the normal level thereof, said outlet consisting of a conduit extending the whole width of the tank, having a 1172
slot or opening the entire width thereof, protected by a partition extending downward from the top into the water, serving as a submerged outlet, extending the entire width of the tank.

British patent No. 3562, of 1868, to Thomas Smith and another, provides for the same kind of inlet and outlet as mentioned in said claim 11 1173
of the patent in suit, the inlet consisting of a chamber on the outside of the tank and extending the whole width thereof through the wall of which are a series of openings being placed below the top and above the bottom of said tank and extending its width, through which the sewage flows to the tank. And the outlet thereof con- 1174
sists of a conduit having a slot or opening, extending the entire width of the tank and being disposed below the top and above the bottom thereof.

British patent No. 364, of 1870, to George W. Wigner provides for an inlet consisting of a con-

duit extending across the whole width of the tank on the outside and comunicating with the tank through a series of openings in the wall for the entire width thereof, said openings being below the top and above the bottom of the tank, being always submerged and non-disturbing in their
1176 action. The non-disturbing outflow is accomplished by a weir.

United States patent No. 184,099, of 1876, to George R. Moore, provides for a tank having a non-disturbing inlet below the surface of the liquid and also a non-disturbing outlet. But the patent states that any number of inlet pipes may
1177 be conducted directly to the tank. This will provide then a series of inlets extending the greater width of the tank and being below the top and above the bottom thereof.

United States patent No. 505,166, of 1893, to Oluf E. Meyer, provides for an inlet with a broadened mouth, extending the whole width of
1178 the tank and used in conjunction with a partition extending from the top of the tank down below the surface of the water thereof, forming thereby a submerged non-disturbing inlet. The tank is also provided with an outlet extending across the whole width of the tank and disposed above the bottom of the tank and below the water level
1179 thereof.

Claim 12 of the patent in suit is the same as claim 7 thereof, excepting the feature of the wide inlet, which, as stated in connection with claim 11, is old. I therefore find no novelty in said claims 11 and 12, unless possibly it be a pipe having a longitudinal slot therein extending the greater part of its length, but such a pipe is not used in defendants' plant.

Q. 44. Claim 20 of the patent in suit is as follows:

"In an apparatus for the purification of sewage, the combination of a septic tank, means for excluding air and light, a non-disturbing inlet for said 1181
tank disposed below the normal water-level thereof and provided with a broadened mouth, a non-disturbing outlet for said tank disposed below the nomal water level thereof and provided with a broadened mouth, and a sewage-conduit connected with said inlet."

Please compare this claim with the prior art of which you have knowledge and state what, if any, 1182
novelty you find in said claim? A. This claim covers a non-disturbing inlet with branches, and a non-disturbing outlet with branches or broadened mouths, said inlet and outlet being below the top of the tank and the tank provided with means for excluding air and light, features very common in the art. In reference thereto I make the following references: 1183

The tanks at Clifton Union, described in Austin's book, hereinbefore referred to, are covered over and made air-tight. They have a non-disturbing submerged inlet provided with a broadened mouth, consisting of a conduit disposed outside of the tank and connecting with the tank by a series 1184
of submerged openings through the wall, comprising a broadened mouth. Austin's proposed tank, hereinbefore mentioned, provides for a non-disturbing submerged inlet with broadened mouth, comprising a series of perforations through the walls of the tank, said openings being below the top thereof, and a non-disturbing outlet below the top of the

1185 level of the water, provided with a broadened mouth, said outlet consisting of strainers or filters through which the water passes laterally. Said tank is provided with means for excluding air and light.

British patent, No. 2329, of 1864, to Thomas
1186 Walker and another, provides for a non-disturbing submerged inlet and a non-disturbing submerged outlet, both being provided with broadened mouths; the inlet consisting of a pipe having several branches and the outlet consisting of an opening in the wall used in connection with a partition, forming a submerged slot in the wall the entire
1187 width of the tank.

British patent, No. 364, of 1870, to George W. Wigner, provides for an air-tight tank having a non-disturbing submerged inlet comprising a conduit extending the width of the tank and being provided with a series of branch openings into the tank below the normal water level thereof, such an arrangement comprising a broadened mouth to the
1188 inlet. The non-disturbing outlet comprises a partition wall extending the whole width of the tank, over which the sewage has to pass.

Scott-Moncrieff's tank, hereinbefore referred to, provides for the use of a non-disturbing submerged inlet with a broadened mouth.

British patent, No. 7134, of 1887, to Wilhelm
1189 Gurtler, provides for an air-tight tank and a non-disturbing inlet disposed below the normal water level thereof, and provided with a broadened mouth, and a non-disturbing outlet disposed below the normal water level thereof, and provided with a broadened mouth, said tank being shown in detail in Figure 7 of the drawings of said patent.

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United States patent, No. 505,166, to O. E. Meyer, September, 1893, provides for a non-disturbing inlet with a broadened mouth, and used in conjunction with a baffle board, and a submerged non-disturbing outlet provided with a broadened mouth.

I therefore do not find any novelty in said Claim 20 of the patent in suit, as I understand the same. 1191

Q. 45. Claim 22 of the patent in suit is as follows:

> "In an apparatus for the purification of sewage, the combination of a septic tank, means for excluding air and light, a non-disturbing inlet for said tank disposed below the normal water-level thereof, a non-disturbing outlet for said tank disposed below the normal water-level thereof, and a sewage- 1192
> conduit connected with said inlet."

and a sewage-conduit connected with said inlet."

Please compare this claim with the prior art of which you have knowledge and state what, if any, novelty you find in said claim? A. As I understand this claim, it was anticipated in every particular in the Mouras apparatus, as set forth in the French, British and United States patents, and as 1193
applied in practice. Also in the Waring and Phillbrick tanks, in the Union tank, in the tank at the Worcester State Hospital, in the Glover cess-pool—all of which I have hereinbefore mentioned and fully described.

Counsel for defendants offers in evidence, copy of U. S. patent to Garryt D. 1194
Mitchell, No. 580,793, dated April 13, 1897, and the same is marked "Defendants' Exhibit, Mitchell, U. S. Patent."

Counsel for defendants offers in evidence, a translation of the French patent, of September 22nd, 1881, to L. Mouras, and the same is marked "Defendants' Exhibit, Translation of Specification of Mouras' French Patent."

Counsel for defendants will also introduce later, certified copy of the specification and drawings of the said French patent,
1196 to be obtained from the United States Patent Office.

Direct Examination closed.

Cross Examination of Mr. Snow by Mr. Gifford:

XQ. 46. Did you testify to the deposition of Frank Herbert Snow, which I now show you, in the printed record of the case in the United States Circuit
1197 Court for the District of Rhode Island, entitled American Sewage Disposal Company, of Boston, v. City of Pawtucket, said deposition, being dated February 3, 1904? A. Yes.

At the request of complainant's counsel, the deposition just identified and which extends from page 300 to 443, of said record,
1198 is marked for Identification, "Snow's Pawtucket Deposition."

XQ. 47. In answer to the question as to when the term "septic" was first used in this art, did you in that deposition testify:

"It was first used by Mr. Cameron, it being the term applied to the tank which he constructed and
1199 put in operation at Exeter, England, during the latter part of 1896. It was not known to me, and, so far as I have knowledge, to engineers in this country until 1897, when there appeared various discussions as to the merits or otherwise of the Cameron patent."

A. Yes.

XQ. 48. From what source did you derive your knowledge of the septic tank that Mr. Cameron put into operation at Exeter, England, during the latter part of 1896? A. Partly from various publications describing Mr. Cameron's claims, and partly from conversation with experts of the State Board of Health of Massachusetts, and others interested in the art. 1201

XQ. 49. So far as you can remember, please mention where you saw the Cameron septic tank of Exeter, England, published in 1897; that is to say, in what publication? A. I can not state now from recollection the name of any publication of that year describing the Exeter plant which I read at that time. 1202

XQ. 50. Can you mention any of the publications which were among the first in which you saw Mr. Cameron's Exeter septic tank experiments published? A. My recollection is the first publications were from England, my attention being called to them in the offices of the Massachusetts State Board of Health. 1203

XQ. 51. Can you name any of the experts or officers of the Massachusetts State Board of Health who were among the first with whom you talked as to Mr. Cameron's septic tank experiments at Exeter? A. Mr. F. P. Stearn, formerly Chief Engineer of the State Board of Health and now Chief Engineer of the Metropolitan 1204
Water & Sewerage Board, was among the first experts to discuss the Exeter system with me. I think, however, this must have been in 1898, at the time I was engaged in designing a tank for Mr. Stearn.

XQ. 52. At the time in 1897 when Mr. Cam-

1205 eron's septic tank experiments first came to your attention, what position did you hold with respect to any sewage disposal plant? A. I was in charge of the operation of the sewage disposal work at Brockton, Mass.

XQ. 53. Up to that time had you been ac-
1206 customed to remove the sludge from the bottom of the tank at Brockton every day, that is, once every day? A. Yes.

XQ. 54. And what had you been accustomed to do with the sludge so removed every day? A. Dispose of it broadcast upon drying-out beds, especially set apart for that purpose

1207 XQ. 55. Since Mr. Cameron's septic tank experiments at Exeter were brought to your attention, in 1897, how many plants in the United States have you or your firm constructed, comprising the combination of the septic tank in which the sludge was permitted to remain and liquefy indefinitely with subsequent filter beds for
1208 the septic effluent? A. Ten.

XQ. 56. About how large a population altogether do those ten plants dispose of the sewage from? A. From 45,000 to 82,000.

XQ. 57. When did you design the first of the ten plants you have referred to? A. In the latter part of 1898. I am referring now to tanks
1209 constructed since 1897.

XQ. 58. Generally speaking, is it true of each of those ten plants that the size of the septic tank or tanks has been equal to the total daily flow of sewage of the system so that the time for the passage of sewage through the septic tank is about 24 hours? A. Yes.

XQ. 59. Is it also true of those ten tanks that some of the septic tanks have never been cleaned out, and the first tank constructed has been claned out but once in three years? A. Yes.

XQ. 60. Is it true, according to your understanding, that Mr. Cameron adopted the period
of twelve to twenty-four hours as the time for 1211
sewage to occupy in passing through a septic tank, and there is no knowledge at the present time which warrants the discarding of this period as a general rule for the design of the dimensions of a septic tank? A. It is true that this period of time was the one which the sewage occupied
in passing through the first small tank of the 1212
three tanks which Mr. Cameron used at Exeter. There is no evidence known to me that Mr. Cameron had previous knowledge or intended to use this period of time in this first small tank experiment. But he afterwards used about this same time. The ordinary passage through the third
or last large tank at Exeter was about eighteen 1213
hours. This size or capacity of tank has been common in the art in connection with ordinary settling tanks, and today, as formerly, it is thought good practice, owing to the irregularity in the flow of the sewage during the twenty-four hours, to provide for tank capacity of about one
day's flow. I am not willing to state, however, 1214
that this period of passage through the tank, or a tank capacity of a day's flow, is essential to septic action. I do not think it is. The indefinite retention of the solids of the sewage is the important point, and if these could be retained, or rather be separated from the bulk of the sewage,

and retained in the tank, at the same time permitting the passage of the liquid through the tank in a short time, for instance, in a space of a few moments, I know no reason why the liquefying of the solids so intercepted would not go on.

1216 XQ. 61. Did you in the Pawtucket case testify as follows:

"R-d-Q. 227. You have several times stated that twelve to twenty-four hours was the best time for sewage to occupy in passing through a septic tank. For how long a time has it been known that the best time for that purpose is within those limits? A. Mr. Cameron adopted this period, and, as I
1217 have previously testified, there is no kowledge at the present time which warrants the discarding of this period as a general rule for the design of the dimensions of a septic tank?

A. Yes.

XQ. 62. Did you also testify in the Pawtucket case as follows:

"R-d-Q. 220. Referring again to the plants you
1218 have built and planned which include a septic tank, does the sewage in those tanks remain at a constant level and how deep is the sewage in them? A. The depth of the sewage is from seven and a half to nine feet and the sewage is maintained at a constant level in the tank."

A. Yes, but I would like to modify that answer now by stating that in one of the tanks, while
1219 the depth is the same; that is, from seven and a half to nine feet, the sewage is not maintained at a constant level in the tank.

XQ. 63. To what extent does the level of the sewage in that one particular tank fluctuate? A. I can not state in figures what this fluctuation is, but the tank is designed to act as a storage reservoir for storm water which comes from the sewer system during periods of precipitation.

XQ. 64. In the ten plants comprising septic tanks that you have built since you first knew of the Cameron tank in 1897, what relationship have you observed between the length and
breadth of the septic tanks. A. Generally speak- 1221
ing, they are about twice as long as wide.

XQ. 65. And what is their construction with respect to the inlet and outlet openings? I mean as to the location and extent of said openings? A. In every tank the sewage is conducted therein below the surface and above the bottom thereof
and is drawn from the tank at the opposite end 1222
from the inlet from below the surface and above the bottom of the tank.

XQ. 66. How far across the end of the tank do the outlet openings extend? A. Across the greater width of the tank.

XQ. 67. And how far across the end of the tank 1223
do the inlet openings extend? A. There are usually two or more openings discharging sewage into the tank, arranged so as to comprise non-disturbing inlets, said openings being spaced equi-distant from the sides of the tank.

XQ. 68. In all of these ten plants comprising
septic tanks, which you have constructed since 1224
learning of the Cameron experiments in 1897, is the septic tank effluent exposed to light and air between its exit from the tank and its entrance into the filtering material? A. Yes.

Adjourned to Thursday, June 22, 1905, 10:30 A. M.

1225 F. Herbert Snow.

New York, June 22nd, 1905, 10:30 A. M.

Met pursuant to adjournment.

Present, Counsel, as before.

Cross Examination of Mr. Snow Continued:

It Is Stipulated that the time for taking
1226 testimony herein be extended to August 1, 1905.

XQ. 69. Is the Saratoga plant, charged to infringe in this case, one of the ten plants of your construction above referred to A. Yes.

XQ. 70. Returning now to the Brockton sewage plant, of which you had charge, is it approximately
1227 true that in 1896 the total amount of sludge pumped out of the tank or tanks on to the filter beds was 25,000,000 gallons, and that this sludge after draining and drying, was removed from the filter beds by raking and scraping to the amount of 145,000 pounds, and was then burned? A. Yes. I cannot answer this question from recollection, but I
1228 have before me a copy of the Engineering News, dated May 20, 1897, in which there is an abstract of my report on the operation of the Brockton plant for the year 1896, in which I find the figures mentioned in the question, stated, and I believe them to be correct. The sludge was really a concentrated sewage and should not be taken to represent or
1229 mean the same as sludge deposited in a tank and composed very largely of solid matter. It will be noticed that the concentrated sewage called sludge, amounted to 25,000,000 gallons for the year 1896, or approximately 100,000 tons. This heavy liquid was pumped through a 24 inch cast iron pipe for a distance of three miles on to the sludge filters,

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through the liquid percolated and left the solid on the surface of the sludge beds. This solid matter, so strained and dried amounted to 73 tons only for the year. The comparison of the two figures, 100,-000 tons of the sludge in its liquid form and 73 tons in its dried out form, conveys a better idea of the proportion of the 25,000,000 gallons which was 1231
really solid matter.

XQ. 71. Did the figures given in the last question for Brockton in 1896 also hold approximately good for that plant in 1897? A. No. The quantity of sewage and its strength increased annually.

XQ. 72. So that for the year 1897 there was
more than 145,000 pounds of the drained and dried 1232
sludge removed by raking and scraping from the filter beds and burned; is that correct? A. I think such was the fact.

XQ. 73. Was the practice at that time, 1896 and 1897, at Brockton, to pump the settled sewage from the tank to the filter beds late each day and when
in the course of this pumping, the sludge was reach- 1233
ed, to bring into play an agitator to stir up the sludge before it went to the pump? A. Yes.

XQ. 74. After learning of the Cameron septic tank experiments at Exeter, England, in 1897, what, if any experiments with a septic tank did you try at Brockton in 1898, before you designed the
first of your ten septic tank plants in the latter 1234
part of 1898, as you have stated in answer 57? A. The Brockton tank was operated to retain the settled solids and the floating scum in the tank, at the same time permitting the daily pumping of the liquid sewage out of the tank on to the filter, the object of this experiment being to ascertain to what

extent the dissolving actions would occur under these conditions.

XQ. 75. Would the following, which I have taken from an article in the Engineering News of February 2, 1899, be a correct description of the experiments referred to in your last answer:

1236 "In the fall of 1898 it was decided to operate the (Brockton) reservoir as nearly as possible like a septic tank. Accordingly, for the eight weeks between Sept. 6 and Nov. 29 no sludge was sent to the sludge beds. It was necesary to pump from the reservoir, and this of course led to the introduction of fresh air and some stirring up of the accumulated solids, both material variations from the septic tank practice. These facts should be kept in mind
1237 when comparing the results here with the claims made for the English septic tank. The regular sewage sent to the beds each day had ample time for septic action to take place in it; but new supplies of air were introduced daily, and when the sewage was pumped from the tank the suction drew some of the solid matters with it. Such solid matter as remained in the reservoir appears to have stayed at the top. At the end of four weeks there
1238 was a layer fourteen inches in depth of this floating matter at the farther end of the reservoir, diminishing in thickness to zero at about ten feet from the other end. The reservoir is 42 feet wide 118 feet long and has a storage depth of 12 feet. At the end of eight weeks this layer was 24 inches deep at the influent end and ten inches at the other. The material was a black, greasy mass between peat and mud in consistency with a green leather-like surface. If a
1239 stick were thrust through it the hole made would fill with sewage and remain for a long time. This stuff always stayed at the top of the tank and observations indicated that there was no accumulation on the bottom, samples of the contents of the tank being collected at different depths and analyzed. While these septic experiments were in progress the sewage sent to the beds was much stronger than before and its character changed

 1240

more than usual during its stay in and transit through the forced main. Instead of materially increasing the dissolved organic matter in the applied sewage, and decreasing that in suspension, however, analysis showed that the dissolved albuminoid ammonia had increased but eleven per cent. and the free ammonia only twenty-two per cent. while the suspended albuminoid ammonia in- 1241
creased 129 per cent. and the oxygen consumed 34 per cent. and the total solids 38 per cent. At the conclusion of the experiments the sludge which had been accumulated for eight weeks in the form of the floating mass before described, was stirred up and, with some difficulty, forced out of the reservoir and on to the sludge beds. Its total volume as delivered was 556,000 gallons, whereas the ordinary sludge flow for the same period would have been 1242
3,190,000 gallons the reason being, as above shown, that a large part of the solid matter had gone on to the regular sewage bed. The mass had a most horrible stench and was very difficult to handle on the sludge bed. The water did not drain out readily and the men sent in to dig holes in the sludge to facilitate drainage were so sickened by the odor that they vomited."

A. Yes, as far as it goes, and in so far as it de- 1243
scribes the facts as to what happened.

XQ. 76. How do you account for the fact that this attempt to operate the Brockton tank as nearly as possible like a septic tank, in 1898, proved to be such a failure, so far as securing the liquefaction of the solids in the sewage was concerned?
A. I do not know what is meant by the words, 1244
"such a failure," in the question, but it was a fact that the liquefaction of solid matters was not promoted in the Brockton tank to as substantial a degree as is secured in tanks in which the normal level of the water therein is maintained at a more constant height. The depth of the liquid in the

Brockton experiment referred to varied from twelve feet to, I think, about four feet, possibly not quite so much, but at any rate the tank was emptied daily of a large part of the liquid, and this caused the scum upon the surface to drop to very near the bottom, necessarily causing an agitation. To this
1246 very great fluctuation I attribute the negative results. On the other hand, a very marked change in the quality of the sewage was effected during this experiment, and some degree of lequefaction occurred.

XQ. 77. Were there any other conditions in that 1898 Brockton experiment tending to interfere with
1247 the promotion of the liquefaction of the solid matters in the tank? A. I attribute the said negative results almost wholly to the excessive fluctuation of the water level in the tank.

XQ 78. When you designed the first of your ten septic tanks in 1898 after this Brockton experiment, how did your design of the tank and its appurten-
1248 ances differ from the design of the Brockton tank in which that experiment was tried? A. It was designed to obviate any fluctuation in the surface of the water in the tank and was provided with an inlet similar to the one in the Brockton tank, but instead of being disposed near the bottom of the tank as at Brockton, it was at mid-depth thereof.
1249 And the outlet of the tank, instead of being at the bottom of the tank, as at Brockton, was disposed at mid-depth thereof, having the same object as the inlet, which was the non-disturbing of the deposits in the bottom of the tank and the floating scum on the surface thereof. This arrangement was not new to me, since I had used it for the same purpose to pro-

mote septic action in a tank constructed by me before 1897, the date mentioned in the question.

All that portion of the answer as to before 1897 objected to as irresponsive and volunteered.

XQ. 79. I now turn to what you have called the "world renowned classical researches of the Massachusetts State Board of Health," the yearly volumes of whose reports from 1890 to 1900, inclusive, I have here present. Why do you honor these reports by the expression, "world renowned classical?" A. Because, so far as I am informed, they are considered so by engineers and scientists engaged in practicing the art of sewage disposal, and for the reasons hereinbefore fully mentioned by me in describing the place in the development of the art which these experiments take. 1251 1252

XQ. 80. Please give the Court an idea as to the ability and facilities that the Massachusetts State Board of Health had for keeping abreast of the most advanced knowledge in this art and its practical application? A. The ablest chemists, bacteriologists and other experts were associated with the Board and ample appropriations by the State afforded the Board every facility to carry out the object of the experiments, which I have hereinbefore stated was to ascertain how much sewage could be purified by soils existing in various parts of Massachusetts. 1253 1254

XQ. 81. In your 21st answer, in summing up what was generally known at the close of 1895, by those best qualified and practicing the art or following the Massachusetts Reports you said, "It will be noticed that the *idispensable element* of all these accelerated processes was the *preliminary* removal of the sludge."

In 1896 and 1897, what means do the Reports of the Massachusetts State Board of Health show that they were employing for this preliminary removal
1256 of the sludge? A. Plain subsidence tanks and subsidence aided by chemicals, and straining tanks and rapid straining, aided by a current of air drawn through the strainer, and the staleing of sewage, the last being accomplished by the use of a sewer in which the changes, mechanically, chemically and bacterially, were observed, and the benefits thereof noted.

1257 XQ. 82. In your Pawtucket testimony, did you testify and do you now testify also as follows:

"R-d-Q. 218. At what point do you draw the line between a staleing of sewage and septic action which is intentionally induced? A. In from six to eight weeks time, the intended action of a septic tank may be expected to become established, and, so far as I am able to judge, it will not occur much
1258 before this time. In making this statement I am referring to the time when the liquefaction of the solid matters in the bottom of the tank, or on the top of the liquid in the tank begin to be liquefied to an appreciable extent, and I do not refer to the putrefying action which exists even to some extent, possibly, in the sewage before it enters the tank."

A. That was my testimony in the Pawtucket
1259 case, and I now testify the same, but I wish to make the answer or my meaning more plain, if possible. In my opinion, from six to eight weeks is required in which the liquefying action referred to will be established to the extent of creating an equilibrium beyond which the solids will not accumulate on the bottom of the tank or on the top thereof. Up to

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this time these accumulations will be very rapid, the activities of the liquefying organisms not having reached the degree sufficient to successfully cope with the solids constantly being added to those already accumulated in the tank. But after this period they have sufficiently increased and there is therefore no further accumulation of these matters. 1261
I wish to be clearly understood as stating that the liquefying action does occur to an appreciable extent prior to this time. It is the equilibrium about which I was referring in the answer to question R-d-Q. 218, above cited.

XQ. 83. Did you also testify in the Pawtucket case, and do you now testify, as follows: 1262

"The best practice requires that the tank be built of sufficient capacity to hold quite an accumulation of solids, because it is known that sufficient time must occur for the installation of the desired bacterial life. I have observed that from eight to twelve weeks may elapse from the starting of a septic tank before there is rapid evolution of gas, and during this time the solids accumulate very 1263
rapidly . . . . I do not mean to be understood as saying that substantial septic action may not be secured in less than eight weeks, or more than twelve weeks, but from my observation and experience with average sewerage, I believe that the time will be in the vicinity of eight to twelve weeks. My experience and observation I find to have been corroborated by the experiments of the Massachusetts State Board of Health, pub- 1264
lished in the Board's Annual Report for 1899, page 423, which shows that in a tank in which sewage passed through in thirty hours the rapid evolution of gas did not begin until about the end of the second month of operation of the tank, and from that time on the gas given off in volume equaled one gallon to every twenty-two and a half gallons of the sewage passing through."

A. I did so testify and will testify the same now. It is understood that in this quoted testimony I was then referring, and now refer to the time required for the establishment of the equilibrium between the accumulated solids in the tank plus those being constantly added thereto by the inflow of the sew-
1266 age, and the bacterial activities whereby further accumulations are prevented. Furthermore, this general statement pertains more particularly to the application of the septic action to tanks of large size.

Recess until 2 P. M.

XQ. 84. In the 1896 Report of the Massachu-
1267 setts State Board of Health, do you find the methods of preliminary removal of the sludge then in vogue stated as follows, (p. 475):

"REMOVAL OF SLUDGE FROM SEWAGE.

"Studies of different methods of removing sludge have been continued throughout the year as follows:

1268 "1. Rapid filtration through coarse gravel with the aid of a current of air drawn down through the gravel.

"2. Rapid filtration through coarse gravel with the aid of a current of air forced up through the gravel.

"3. Sedimentation.

"4. Chemical precipitation.

"5. Straining through coke."

1269 A. Yes.

XQ. 85. And in the same report of 1896, do you find the following:

"SEDIMENTATION."

"For several years the supernatant sewage obtained by allowing regular sewage to stand and settle for a definite period has been applied to a sand filter." A. Yes.

XQ. 86. Is the following an excerpt from the 1897 Report of the Massachusetts State Board of Health, (p. 421):

"REMOVAL OF SLUDGE BY SEDIMENTATION, FOLLOWED BY A FILTRATION OF THE SUPERNATANT SEWAGE THROUGH
SAND. 1271

"Experiments in regard to the amount of sludge that can be removed from sewage by allowing it to stand for four hours have been continued since the beginning of 1892. The results obtained have differed from year to year according to the strength of the sewage and the amount of insoluble organic matter in suspension in it. This investigation continued throughout 1897 and during the first two
months of the present year (1898), and the results 1272
obtained are shown by the table on page 415. During the entire period covered by this investigation, with the exception of a portion of 1893, the supernatant sewage has been applied to a sand filter at the station." A. Yes.

XQ. 87. Throughout all of the Reports of the Massachusetts State Board of Health, up to 1898,
do you find any suggestion of utilizing a tank for 1273
the liquefaction of the solid constituents of the sewage by bacterial action or otherwise? A. Yes, all of the filter tanks were used for the purpose of liquefying the solids and changing the sewage matters, both dissolved and suspended reaching the filters or filter tanks into liquid or the lowest miner-
al form. 1274

On page 458 of said Report under the heading "Relation of Free Dissolved Oxygen in Sewage to Increase in Free Ammonia," attention is called to the fact that refuse matters entering the sewer are decomposed in the presence of free dissolved oxygen, and the oxygen of such compounds as

1275 nitrates and nitrites by the bacteria in the sewage, that is, organic matters, are changed to simpler forms. Time is required for this process varying with the numbers and kinds of bacteria and with the nature of the organic matter. On page 459 are the following words:

1276 "Many of the bacteria in fresh sewage are capable of growing in the absence as well as in the presence of free oxygen, and are known according to Pasteur's classification as facultative anerobes. After the sewage becomes stale and the free oxygen all consumed, these particular bacteria continue to live and produce vile odors, a process generally spoken of as putrefaction."

1277 On the same page, under the heading "Free Dissolved Oxygen in Sewage Disappears as Free Ammonia Increases During Passage to the Station," are the following words:

"To apply these principles to the case at hand, we may say, as was stated for the main part in earlier reports, that the sewage in the Lawrence street sewer contains free dissolved exygen, as well
1278 as oxygen in the form of nitrates and nitrites, and that it receives the greater part of its polluting matters only a few minutes before its arrival at the point of collection. The ratio of free ammonia to albuminoid ammonia is comparativey small at this stage, because the time required for bacteria to decompose the crude organic matter of the sewage is insufficient. Next the sewage passes through
1279 the pipe 4300 feet long leading to the station. The time required for this step, usually several hours, is sufficient for the bacteria present in the sewage with the free exygen, together with those bacteria firmly established upon the sides of the pipe, to decompose some of the crude organic matter into free ammonia, and to partially effect the first step in the purification of sewage."

Again, on page 460, under the heading "Initial Steps in the Decomposition and Purification of Sewage'' are the following words:

"The changes which fresh sewage undergoes, and the relative amounts of organic nitrogen yielded as alumbinoid ammonia, are well shown by the following experiment, which is representacive of a series which have been made in the laboratory. As
it is generally supposed that sewage contains no 1281
free dissolved oxygen, it is plain that an important step in advance has been taken in our knowledge of sewage purification. * * * * * * Another point worth mentioning is that, as the crude organic matter is converted to free ammonia, it is the soluble and not the insoluble portions which are the first to undergo this change.

"The results of study in these lines are of value
for two reasons: 1282

"1. They give us a clearer conception of the initial step in the purification of organic matter by bacterial action, a process which is of the utmost importance in the economy of nature.

"2. They pave the way for more substantial knowledge concernig the composition of sewage, and for more accurate data upon the capacity of various filtering materials to purify sewage,
expressed in units of unpurified and unoxidized 1283
substances."

Again, on page 479, I find these words:

"Nitrification in Filter No. III., which received fresh sewage from the Lawrence street sewer, appeared much more slowly in cold weather than in the case of the other two filters receiving partially decomposed sewage. In warm weather there
was only a slight difference, although No. III 1284
required a longer time for complete nitrification to become established."

On page 532, under the heading ''Comparison of Conditions of Experimental Filtration With Those in Actual Practice.''

''II. State of Decomposition of Sewage'' is the following:

1285 "With regard to the composition of the Lawrence sewage it may also be noted that it is somewhat more decomposed than in the case of several of the sewages found at different places throughout the state. This is caused by bacterial action during the interval of time which elapses during the passage of the sewage to the station,—a condition which would exist in sewage disposal works on a
1286 large scale where the filter field is several miles distant from the lateral sewers, or where the sewage passes through a settling tank."

On page 468 of the "Massachusetts State Board of Health Report for the Year 1896," under the heading, "Disposal of Fresh and Stale Sewage," it is stated as follows:

1287 "If, on the other hand, the sewage is stale and has undergone comparatively long—continued mechanical, chemical and bacterial actions, not only is the crude organic matter more finely divided and hence more readily enters the interstices of the filtering material as stated in the last report of the Board, but the sewage has actually lost crude organic matter both by the change of organic nitrogen into free ammonia and also by the
1288 reduction of the organic matters, measured by the oxygen consumed, on account of the formation and liberation of gaseous compounds of carbon. For example, the table given on page 461 of the Report of the Board for 1894 shows that when a bottle of fresh sewage was allowed to stand for twenty-four hours the organic nitrogen (Kjeldahl) decreased 51 per cent. and the oxygen consumed 25 per cent., while the free amonia increased over 100
1289 per cent.

"To illustrate the difference in the disposal of fresh and stale sewage two small tube filters containing equal depths of the same grade of sand were put in operation in May. To one of these filters sewage taken directly from the city sewer and brought immediately to the station has been applied, while the other has received the sewage pumped at the station."

These comprise suggestions of and the actual utilizing of the process of liquefaction of the solid constituents of the sewage by bacterial action brought about in a bottle and in a long sewer both of which for the purposes at the experimental station acted as tanks.

XQ. 88. By "tank" in the last question, I did 1291
not intend to include either a bottle or a sewer or a filter tank. Are the filter tanks referred to in the first paragraph of your last answer those in which the oxidation or nitrification or aerobic bacterial action occurs? A. Yes, those in which the aerobic bacteria and anaerobic bacteria, as well, working under aerobic conditions more 1292
largely, accomplish the work of reducing crude organic matter into a liquid and mineral form.

XQ. 89. Throughout all of the reports of the Massachusetts State Board of Health, up to 1898, do you find any suggestion of utilizing a tank between the sewer and the aerobic action for the purpose not of separating the solid from the 1293
liquid constituents of the sewage, but for the opposite purpose of liquefying the solid constituents and permitting them to remain in this liquefied form in the current of sewage flowing out of the tank? A. Yes, and also no. Yes, in so far as liquefying action will go on in any kind of tank, which action conveys beneficial results 1294
pointed out by the State Board of Health and referred to by me in the answer to question 87. But no, insofar as the use of such a tank had for its object only the liquefying of the solid constituents of the sewage.

XQ. 90. Throughout all the reports of the Massachusetts State Board of Health up to 1898,

do you find any suggestion of any tank between the sewer and the aerobic action, excepting the tank in which the solid constituents of the sewage were separated and removed from the liquid constituents thereof? A. No, with the exception of course of the very important experiments
1296 by the State Board of Health referred to by me in answer to question 87, especially where fresh sewage was taken from the Lawrence Street sewer and applied to one filter and stale sewage was taken out of the tank at the station and applied to another filter. This certainly suggested a tank between the sewer and the aerobic action,
1297 in which tank the solid constituents of the sewage were not separated and removed from the liquid constituents thereof.

XQ. 91. I am endeavoring to word my questions so as to specify a tank in contradistinction to a sewer, but you do not seem to answer them with that understanding, but on the contrary to answer them as though I were asking about a
1298 sewer as well as a tank. Understanding that when I say a tank I do not mean a sewer, and that when I say a non-filtering tank I do not mean a filter tank, will you please answer the following question: Throughout all of the Reports of the Board of Health up to 1898, do you find any sug-
1299 gestion of a non-filtering tank (not a sewer) used in the process of treating the sewage excepting the tank in which the preliminary removal of the sludge or solids from the liquid was accomplished? A. Yes; in the 19th Annual Report of said Board for the year 1887, on page 101, there is a description of a tank, which I have herein-

before described and from which Report I will now quote:

"Near the lower end of the sewer the sewage passes through a cesspool arranged as shown on the accompanying drawing (Plate III) so that the outflow takes places from beneath the surface of the sewage standing in the cesspool. The effect is that objects which either float or sink are held back 1301
until they are sufficiently changed by chemical or other action to flow uniformly with the rest of the liquid, and are prevented from being thrown out upon the ground at the outlet, where lumps of foecal matter, orange peel, and the like, might be offensive or ill-adapted for percolating through the ground. Very little sediment collects in the cesspool, only about one foot in depth in the course of a year. When it fills up the sediment will have to 1302
be taken out."

This tank was an intentional utilization of the liquefying process mentioned in said State Board of Health Report and my authority for answering in the affirmative the question asked.

Complainant's counsel objects to the last answer on the ground that the Re- 1303
port referred to is not present and he has no means of verifying the reference thereto, or its context, and also on the ground that it is not referred to in the answer.

XQ. 92. I have obtained and have present for convenience of reference the ten years of the 1304
Massachusetts State Board of Health Reports from 1890 to 1900, and I now ask you whether, throughout all of those reports now present, up to 1898, you find any suggestion of a non-filtering tank (not a sewer) used in the process of treating the sewage, excepting the tank in which the

preliminary removal of the sludge or solids from the liquid was accomplished? A. No; understanding that the word "tank" excludes from my answer the tank at the Lawrence experiment station and also the sewer leading to it, either separately or taken together.

1306 XQ. 93. What ground have you for stating
that the tank at the Lawrence experimental station, referred to in your answer, was not a tank
in which the preliminary removal of the sludge
or solids from the liquid was accomplished? A.
The tank to which I referred in my last answer
is not indicated on any drawing of the Reports
1307 of said Board now before me. By it I did not
mean the main tanks into which the sewage is
pumped for subsidence or other experimental purposes, but a chamber at the foot of the sewer
into which the suction end of the pump is located
and from which the sewage is pumped from the
sewer to the station. I should prefer to substitute for the word "tank" in the last question
1308 the words "pumping chamber," and even this
chamber dissociated from the sewer leading to
it would not suggest the use of a tank in which
the preliminary removal of sludge or solids from
the liquid was not accomplished.

XQ. 94. I do not think that I quite under-
1309 stand your position, but to get at what I am endeavoring to bring out, I will change the form of
my question as follows:

Throughout all the Reports of the Massachusetts State Board of Health, prior to 1898, that we have present (1890 to 1900), do you find any process for the treatment of sewage described inconsistent with the principle that you have

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stated in your 21st answer, namely, that an indispensable element was "the preliminary removal of the sludge" from the liquid portion of the sewage? A. No.

XQ. 95. Will you please look at the paper now shown you and state whether you find it to correctly quote the Reports of the Massachusetts 1311
State Board of Health so far as the extracts which it purports to give from those reports for the years 1898, 1899, and 1900 are concerned; the Reports of those years being here present? A. I have no doubt it is correct, if I discover any errors later on I will say so.

Complainant's counsel has the paper 1312
shown the witness marked for identification as "Massachusetts Board of Health Report on Septic Tank."

XQ. 96. Do you understand that the following in the Massachusetts State Board of Health Report for 1898 referred to the Cameron septic tank system? (p. 438.) 1313

"SEPTIC TANK SYSTEM.

"The processes by which this percentage of suspended organic matter can be reduced are now being taken advantage of by the so-called septic tank system (first in operation in Exeter, Eng.) the main feature of which is an air-tight tank into which the sewage passes to be retained for a time in order to allow the bacteria of decomposition, 1314
and subsequently those of putrefaction, to break up the organic matters into simpler forms. During the year we have studied this method with very interesting results."

A. I understand that the words "so-called septic tank system" refer to the Cameron septic tank system first in operation in Exeter, Eng-

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land. Also, that this "so-called septic tank sys-
tem" is stated by the State Board of Health in
said quotation as taking advantage of the pro-
cess by which the percentage of suspended organ-
ic matters can be reduced. I further understand
that this "so-called septic tank system is stated
1316 by the above quotation to consist of 'certain
features, that is, an air-tight tank, and its object
is to retain sewage for a time in order to allow
certain things to be accomplished. I do not un-
derstand that the whole quotation refers to the
Cameron septic tank system, but more particu-
larly the apparatus by which the process by
1317 which the percentage of suspended organic mat-
ters can be reduced was taken advantage of by
the "so-called septic tank system."

XQ. 97. Following this mention of the Cam-
eron septic tank system in the Massachusetts
State Board of Health Reports for 1898, does it
appear from said Report that the Massachusetts
State Board of Health took up the septic tank
1318 subject and experimented with the septic tank
extensively for years? A. Yes.

Adjourned to Friday, June 23, 1905, 10:30
A. M.

New York, June 23rd, 1905, 10:30 A. M.

Met pursuant to adjournment.

1319 Present: Livingston Gifford, Esq., for com-
plainant; Ephraim Banning, Esq., for defendants.

Cross-Examination of Mr. Snow Continued:

(Witness states as follows:)

I now have before me the 19th Annual Report
of the State Board of Health of Massachusetts
being for the year 1887, to which I referred in

my answer to XQ. 91, quoting from page 101 of said Report.

XQ. 98. In the Massachusetts State Board of Health Report for 1887, page 101, does the following sentence immediately follow the excerpt you quoted in answer 91?

"It takes about half an hour for sewage to pass 1321
from the dye house through the sewer, which is nearly 3200 feet in the extreme length, to the outlet where it flows out on the surface of the ground."

A. Yes.

XQ. 99. Returning now to the experiments of the Massachusetts State Board of Health, with the septic tank system, after the mention of Cam-
eron, how many pages of the Reports of 1898, 1322
1899 and 1890, respectively, do you find devoted to the experiments with the septic tank system and the filtration of the septic tank effluent? A. In answering this question to avoid any misunderstanding of my meaning of the word "septic tank" as describing what the State Board of
Health did, I will quote from page 438 of the 1323
Report of the Massachusetts State Board of Health for 1898, said quotation following that made in XQ. 96:

"During the year we have studied this method with very interesting results. An air-tight wooden tank, divided into two compartments by a partition midway in the tank, has been used as a septic tank.
The sewage flows into one compartment, and over 1324
this partition into the other, from which it is withdrawn by means of a faucet midway between the top and bottom of the side of the tank. Thus we avoid drawing out either the sediment from the bottom of the tank or the fat and fatty matters which accumulate upon the surface of the sewage. The sewage remains in the tank from 24 to 36 hours, and the tank is always kept full, sewage

1325 being run into the tank when any is withdrawn, and at the same rate."

Also on page 370 of the Massachusetts State Board of Health Report for the year 1900, under the heading "Septic Tank, A Receiving Average City Sewage."

1326 "This tank experiment was begun during the latter part of 1897, and the results obtained up to Jan. 1, 1900, are given in previous reports. The construction of the tank during the first year and a half of its operation was as stated in the last report, but a change was made early in 1900,—the sewage and sludge in the old tank being transferred to the new one,—and as now constructed it is an air-tight wooden tank, divided by two partitions
1327 into three equal compartments. Floating partitions also prevent the passage from one compartment to another of the scum on the surface of the sewage. The sewage flows through a pipe in the top of the tank, which empties midway between the top and bottom of the first compartment, and is withdrawn from the further end of the tank at the same depth, the pressure of a body of sewage in the feed tank above keeping the flow fairly con-
1328 stant."

With this understanding of the State Board of Health septic tank, I answer the question as follows: In the said 1898 Report, out of 51 pages devoted to sewage disposal experiments, 8 refer to the septic tank system and the filtration of the effluent thereof, and for the 1899 Report, out of
1329 a total of 65 pages devoted to sewage treatment, 14 thereof related to the septic tank and the filtration of its effluent, and in the said 1900 Report, out of 62 pages devoted to sewage treatment, 22 thereof referred to the septic tank system and the filtration of the septic tank effluent.

XQ. 100. In view of the statement quoted in

your last answer, that the septic tank experi-
ments of the Massachusetts State Board of Health
commenced in the latter part of 1897, how long
do you understand that they were in commenc-
ing these septic tank experiments after learning
about Mr. Cameron's septic tank at Exeter, Eng-
land? A. I understand that the experiment 1331
with this tank, which the State Board of Health
called a septic tank, because of its then extensive
use as a term in England in connection with the
dissolving process taking place in sewage, was
begun in the latter part of 1897. I do not know
how soon this experiment was started after the
large Exeter tank, which was put in use in the 1332
summer of 1896, came to the notice of the said
Board of Health. It, in my opinion, could not
have been longer than one year previous to the
time the 1897 experiment was started that the
Massachusetts Board were influenced, if in fact
they were influenced at all, by what was done at
Exeter. The reason for this opinion is that Cam- 1333
eron's first two tanks were small affairs and so
far as I am informed did not attract attention
broadly.

XQ. 101. Are the following excerpts from the
Massachusetts State Board of Health Reports for
the years 1898 and 1899:

From Report for the year 1898: 1334

"The results obtained from these three filters
are very instructive and show that the septic tank
process for the initiation of the purification of sew-
age is one of much interest."

From Report for the year 1899:

"From the results obtained in England and at
the Lawrence Experiment Station during 1898 and

1335 1899 it has been fully demonstrated that the addition of a septic tank to a sewage purification plant may be made of great value in many instances."

A. Yes.

XQ. 102. As I understand it now, prior to obtaining knowledge of Cameron's septic tank system, the Massachusetts State Board of Health in its
1336 filtration of sewage had invariably proceeded upon the principle that (to use your words) "the *indispensable element* of all these accelerated processes was the *preliminary* removal of the sludge." But that after obtaining knowledge of the Cameron septic tank system, said Board instituted the series of experiments whereby they reached the conclusions
1337 stated in my last question. Is this correct as you understand it? A. Yes, but I do not mean to be understood as infering by this answer that the principle, that "the indispensable element of all these accelerated processes was the preliminary removal of the sludge" was set aside or in any way changed. But I do mean that the State Board con-
1338 structed an apparatus which they designated as a "septic tank," because this was the term then commonly used in reference to an apparatus in which the solids were separated from the liquids, in which, at the same time, the advantage of the solvent action taking place in tanks was availed of, and in this apparatus the said Board observed to what ex-
1339 tent the dissolving action could be carried, and the conclusions referred to in the question relate to the experiments of the Board whose object was to find out the limitations of the natural solvent action in sewage when confined in a tank like the one used in the experiment.

XQ. 103. And as I understand it, prior to ob-

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taining knowledge of Cameron's septic tank system, the methods employed for the preliminary removal of the sludge were those set forth in the Report for the year 1896, (p. 475), namely:

"1. Rapid filtration through coarse gravel with the aid of a current of air drawn down through the gravel. 1341

"2. Rapid filtration through coarse gravel with the aid of a current of air forced up through the gravel.

"3. Sedimentation.

"4. Chemical precipitation.

"5. Straining through coke."

Is that as you understand it? A. I find this same statement in reference to the studies of differ- 1342
ent methods of removing sludge and sewage on page 463 of the Report of said Board for 1895, including one other method:

"Rapid filtration through medium coarse coke, with a current of air forced up through the coke."

And on page 458 I find another method mentioned as affecting not the preliminary removal of the 1343
sludge, but the preliminary composition of the sludge before it reaches the filters, which comprises, as stated on said page 458, and also on page 459 of the said 1895 Report, a mechanical, chemical and bacteriological change in the sludge or organic matter in suspension of importance. This should be classed with the other methods of preliminary 1344
treatment of sludge mentioned in the question in order to fully cover said methods, as I understand them.

XQ. 104. The last paragraph of your last answer I understand to refer to "stale," as distinguished from "fresh" sewage. Do you understand that up

1345 to the time they obtained knowledge of Cameron's septic tank system, the Massachusetts State Board of Health in its filtration of sewage had invariably proceeded upon the principle that the indispensable element of all these accelerated processes was the preliminary removal of the sludge from the liquid
1346 whether the sewage was stale or fresh; meaning by "preliminary removal," the separation of the sludge from the liquid so that the sludge was prevented from going to the filter? A. Yes, with respect to the high rates of filtration, but not with respect to slow sand filtration. On to some of the filters all the constituents of the
1347 sewage, suspended and solid, were applied in crude form, there being no attempt at a preliminary removal of the solids from the sewage.

XQ. 105. In operating upon stale sewage, what do you understand to have been the difference in principle between the manner in which the Massachusetts State Board of Health preliminarily disposed of the sludge before they obtained knowledge
1348 of the Cameron septic tank system, and the manner in which they preliminarily disposed of the sludge in their septic tank experiments after obtaining knowledge of the Cameron septic tank system? A. As I understand the question, my answer is: Before the State Board of Health built the
1349 tank, they called "septic tank," certain mechanical, chemical and bacteriological actions were observed to have occurred on the passage of the sewage to the experiment station, which changes were of a character helpful to the subsequent filtration of the sewage, and the difference in principle between what was observed about these changes before the said tank experiment and after it, was one of degree and

not of kind. The tank experiment being conducted
to accelerate and extend the mechanical, chemical
and bacterial changes occuring in sewage.

XQ. 106. Would it not be a correct answer to the
last question to say that the principle for prelimi-
nary disposal of the sludge upon which the Massa-
chusetts Board proceeded, prior to obtaining knowl- 1351
edge of the Cameron septic tank system, was to re-
move the sludge as solid matter from the liquid so
as to prevent it from going to the filter, whereas in
the use of the septic tank after obtaining knowledge
of the Cameron septic tank system, the Board pro-
ceeded upon the principle of not removing the
sludge as solid matter, but of converting it into a 1352
liquid and permitting it to remain with the original
liquid of the sewage and to go to the filter? A.
No.

Recess.

XQ. 107. What words in the last question would
have to be changed in order to enable you to answer
in the affirmative? I ask this question because it 1353
seems to me obvious that my last question states
correctly the practice of the Masachusetts Board
before and after obtaining knowledge of the Cam-
eron septic tank system, and I therefore assume
that your negative answer must be because I have
inadvertently used some word that you object to.
A. My answer to the last question was not an 1354
evasion of the intent of the question, as I under-
stand it, nor is it attributable to the inadvertent use
of any word. I based my answer, as I understood
the question to be based, upon the practice of the
Masachusetts Board before and after its use of the
tank called "septic tank," in 1897.

XQ. 108. In answer 104, you have said that in

1355 some of the Masachusetts Board operations there
was "no attempt at a preliminary removal of the
solids from the sewage." In the present question
I do not refer to those cases, but merely to the op-
eration where there was a preliminary removal of
the solids from the sewage, and I ask you whether
1356 the principle of preliminary removal of the solids
from the sewage upon which the Massachusetts
Board proceeded prior to obtaining knowledge of
the septic tank system, involved the removal of the
solid from the liquid, so as to prevent it going to
the filter? A. The question limits my answer to
the operation where there was a preliminary re-
1357 moval of the solid from the sewage, so of course in
all such cases the principle could not do otherwise
than involve the removal of the solid from the liquid
so as to prevent it going to the filter in the form of
solid. But I understand the question to mean more
than this, because it mentions the State Board of
Health's knowledge of the septic tank system. Said
Board's knowledge of septic action existed prior to
1358 its use of the term "septic tank" in 1897, as I un-
derstand it, and I have hereinbefore referred to the
Medfield tank, described in the said Board's report
for 1887, which had for its object more than the
mere separation of the solids from the liquids in
the tank.

1359 So far as the answer refers to the Medfield tank it is objected to by complainant's counsel as totally irresponsive, and also because the reference to the Report of 1887 is not set up in the answer.

XQ. 109. Do you mean by your last answer that you have used the term "preliminary removal of

 1360

the solid," to mean the removal of the solid as a
solid from the original liquid of the sewage, as dis-
tinguished from the liquefication of the solid and
permitting it to remain in liquid form with the
original liquid of the sewage? A. To a greater or
less degree the two operations—the physical re-
moval of a solid as a solid from the liquid by subsi- 1361
dence, and the liquefaction of the solid matters in
suspension—go on simultaneously, and to this ex-
tent, which may be considerable and depending up-
on circumstances, in my answer to XQ. 108, I did
not intend to make any distinction. Confining my-
self, as I understood the question, in the first of the
answer to the physical or mechanical removal of the
solids as a solid. 1362

XQ. 110. Aside from what you have referred to
as the "staling" of the sewage, is it true that the
principle for the preliminary disposal of sludge on
the way of the sewage to their filters, upon which
the Massachusetts Board proceeded prior to obtain-
ing knowledge of the Cameron septic tank system
was to physically or mechanically remove the 1363
sludge as a solid, and prevent it from going to the
filter, whereas, in the use of the septic tank after
obtaining knowledge of the Cameron septic tank
system, the Board proceeded upon the principle of
not physically or mechanically removing the sludge
as solid, but of converting it into a liquid and per-
mitting it to remain with the original liquid of 1364
the sewage and go to the filter? A. In that in-
stance where the Board used such a tank its object
was; first, to intercept the solids in suspension and
retain them in the tank for the purpose of observing
to what extent these solids would pass into liquid
form, in which liquid form, of course, the sewage

1365 F. HERBERT SNOW.

would pass out of the tank to the filter. I do not know when the said Board first knew about what is now called septic action, but assuming that the question intends to fix the date at the time the said Board used the word "septic," I answer that, aside from "staling," and excluding from my answer the
1366 Medfield tank and also the bacterial method of crude sludge disposal, the preliminary disposal of sludge was to physically or mechanically remove it as a solid and prevent it from going to the filter, and subsequent to 1897, excluding other methods, where the septic tank was used, it converted more or less of the solids into liquid, which liquid was
1367 subsequently filtered.

Answer objected to by complainant's counsel as irresponsive, and the attention of the Court is called to the recent answers of the witness as showing the utter impossibility of securing replies to questions as put.

1368 XQ. 111. You have already stated that you testified in the Pawtucket case as follows:

"R-d-Q. 218. At what point do you draw the line between a staleing of sewage and a septic action which is intentionally induced? A. In from six to eight weeks time the intended action of a septic tank may be expected to become established and so far as I am able to judge it will not occur much
1369 before this time. In making this statement I am referring to the time when the liquefaction of the solid matters in the bottom of the tank or on the top of the liquid in the tank begin to be liquefied to an appreciable extent, and I do not refer to the putrefying action which exists even to some extent, possibly, in the sewage before it enters the tank."

In the preliminary treatment to which the sewage

was subjected on its way to filters of the Massachusetts State Board of Health, prior to their obtaining knowledge of the Cameron septic tank system, on which side of the " line " that you there drew between " staling of sewage " and " septic action," did they proceed? A. Prior to 1897, so far as I know, there was no attempt at the Lawerence experiment 1371
station of said Board to carry the dissolving action in sewage to such a substantial degree as to intentionally liquefy all the suspended solids contained in the sewage.

XQ. 112. But after the Massachusetts State Board of Health obtained knowledge of the Cameron septic tank system, the statement of your last 1372
answer did not continue to be true, did it? A. No, not after 1897.

XQ. 113. Is the following an excerpt from an article published in the Engineering News of August 4, 1898, here present, by H. W. Clark, Chemist of the State Board of Health of Massachusetts, Department of Water Supply and Sewerage, 1373
Lawrence, Mass., entitled " Massachusetts Experiments on the Purification of Fresh, Stale and Septic Sewage."

"Quoting from our Reports I have given experiments showing the change in the composition of sewage with increased age; showing also the loss of crude organic matter taking place as sewage grows older; and showing the greater ease with which 1374
intermittent sand filters can dispose of stale sewage than fresh sewage. These facts are now being taken advantage of by the so-called septic tank system first in operation in Exeter, England. This is an air-tight tank into which the sewage passes and is retained for a time in order to alllow the bacteria of decomposition and putrefaction to break up the organic matters into simpler form and

thus reduce the insoluble matter or sludge by causing a considerable portion of the carbon and nitrogen to be so changed that it is either in solution in the sewage or will pass away from it in the form of gas. As I have said, I have given data showing that the action by which this process is made successful have been thoroughly understood
1376 by us for a considerable time, and the fact that sewage would lose a certain percentage of crude organic matter when held in a body has certainly been known. Anyone who has ever had any experience with or noted the changes taking place in an ordinary cesspool must have had their attention drawn to this fact. We have not, however, ever considered that these actions could be utilized as now proposed by the septic tank system." We have however studied the method to some extent during
1377 the past few months with very interesting results. The sewage remains in our tank 24 to 36 hours and is drawn from a faucet midway between the top and bottom and the side of the tank as at Exeter. We thus avoid drawing out the sediment from the bottom of the tank and the fat and fatty matters which accumulate upon the surface of the sewage."

A. Yes.

1378 XQ. 114. Were you acquainted with this W. H. Clark, Chemist of the State Board of Health in Massachusetts? A. Yes.

XQ. 115. Do you know for how many years he was connected with the Board? A. Mr. Clark was an assistant chemist in 1892, and became the chemist in charge of the Lawrence ex-
1379 periment station in 1895, speaking from recollection, and has held the position continuously until today.

XQ. 116. Is Mr. Clark's article, from which the last quotation was taken, introduced by the following paragraph?

"For the past ten years systematic investigation

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in regard to methods of sewage purification have been carried on by the State Board of Health of Masachusetts at the Lawrence Experiment Station which was established largely for that purpose. Many of these investigations can be properly classed under the head of experiments upon purification by intermittent filtration, and many modifications of intermittent filtration have been studied. 1381
Moreover, all these studies have been carried on not with the idea of obtaining results only, but of making clear the essential principles by which the purification of sewage can be effected. It seems to be an opportune time to say this and to present a brief review of a portion of the work of the station during its first eight or nine years of operation, and also of the results of some investigations recently made on account of the considerable quantity of literature recently published in regard to 1382
the results obtained by the so-called septic tank system and bacterial filters of England."

A. Yes.

XQ. 117. Prior to 1897, or about the time when the knowledge of the Cameron septic tank of Exeter, England, came to this country, what were the most reliable text-books in existence on 1383
the subject of sewage disposal? A. Col. George E. Waring's books, Society publications, the Engineering News and the Engineering Record, Rafter & Baker's book and Santo-Crimp's work, come to my mind. Mr. Crimp's book comes the nearest to being a treatise on sewage disposal. Rafter & Baker's book is most reliable and 1384
gives in condensed form American practice, but it is by no means a treatise or complete in detail. Even at the present time there is no book which adequately treats of the whole subject of sewage disposal.

Adjourned to Saturday, June 24, 1905, 10:30 A. M.

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New York, June 24th, 1905, 10:30 A. M.

Met pursuant to adjournment.

Present, counsel as before.

Cross-Examination of Mr. Snow Continued.

XQ. 118. Do you consider that it was responsive to the last question which inquired exclu-
1386 sively for text-books for you to include such periodical newspapers as the Engineering News and the Engineering Record? A. Possibly not. The weekly publications of the Engineering News and the Engineering Record could not be said to be text-books.

XQ. 119. Are the following excerpts from the
1387 Santo-Crimp book of 1890 entitled "Sewage Disposal Works?"

On page 21, quoting from the "Report of the Committee Appointed by the Corporation of Glasgow in 1880, to Inquire Into the Various Methods of Sewage Disposal":

"The sewage sludge is the troublesome, not to
1388 say dangerous element in all such processes, especially that from lime precipitation, which changes more rapidly than that produced by the action of alumina or oxide of iron. The first and absolutely essential preliminary to the adoption of any method of treatment by precipitation is to arrange for the systematic removal of the sludge from the works. To begin sewage treatment without this is to end
1389 in the creation of a gigantic nuisance and become involved in an almost hopeless struggles to suppress it. Sewage sludge may be disposed of in four ways—it may be compressed into portable cakes; or it may be conveyed in a semi-fluid condition to the open sea; or it may be used to make up waste land; or it may be dug into the ground so producing a highly fertile soil."

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On page 23, quoting from the "Conclusions of the Commissioners Appointed by the Municipal Authorities of the City of Turin to Inquire Into the Methods Adopted for the Disposal of Refuse in Various European Towns":

"The only method recognized up to the present time as really efficacious for the purification of 1391
sewage is irrigation carried out in a proper way upon suitable soil; after the separation of the suspended matters this method is deprived of danger and inconvenience and in our district should give the best agricultural results."

On page 54:

"SETTLING TANKS.

"*The primary object* of the settling tank at sew- 1392
age disposal works is the separation of the suspended matters from the liquid sewage together with a certain proportion of the dissolved impurities, the design of the tank should be such as to bring the sewage to rest or nearly so in the shortest time practicable and admit of the solid matters being removed with the minimum labor.

"*Continuous v. Absolute Best System.*—The details will to some extent depend upon the mode of 1393
treatment of the sewage and whether the 'continuous' or 'absolute rest' method is adopted. In the former case, the sewage is allowed to pass continuously through the tank, but the forward movement is sufficiently retarded to admit of the solid being deposited, while in the latter case a tank is filled with sewage and after a certain period of quiescence the liquid is drawn off, leaving the solids on the floor of the tank. At first sight it 1394
would appear that the absolute rest system is the preferable, since the deposition of the solids would more likely be perfectly effected; but after trying both systems the author found that the continuous system possesses certain advantages which more than compensate for the absence of absolute rest.

"*Cleansing of Tanks*—When a tank has been filled, and, after deposition of the solids, the clarified

1395 water has been drawn off, the sludge remains on the floor of the tank, and unless this is removed with each operation, the re-admission of the sewage is attended with a stirring up of the sludge—it is washed in short—and the sewage becomes unduly charged with the dissolved matters contained in the sludge. The cleansing of the tank after each time of filling is an expensive operation.

1396 "When the continuous system is adopted, the sewage quietly flows through the tank, or a series of tanks, and if the forward rate is such that two hours elapse between the time of its entry and exit, the suspended solids will be effectively removed, provided suitable chemicals have been properly used in the treatment of the sewage. In this system the tank should be cleansed at least once in three days, as the decomposition of the settled sludge is

1397 attended with the production of foul gases, principally carburretted hydrogen (marsh gas) which causes the sludge to rise to the surface in great masses, slowly to subside again on the liberation of the gases. The effect of the second admixture of the sludge with the sewage is to cause the latter to become very foul and as the lightest and most offensive matters are the last to settle and the first to rise again, and as these matters subside near the

1398 outlet of the tank, the importance of keeping the tanks clean can not be too strongly urged."

A. Yes.

XQ. 120. In view of that part of the above quotation from Santo-Crimp's book of 1890, stating that

1399 the tanks should be cleansed at least once in three days, as the decomposition of the settled sludge is attended with" &c.

I ask you whether you find any statement in this book to the effect that any advantage could be obtained by the putrefaction of the sludge in the tank? A. I find on page 90 of said book the following:

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"The first step towards the disposal of sewage sludge is the separation from the solids of as much water as possible in the shortest practicable time, in order, first, that the bulk may be reduced, and, secondly, that time should not be given for the production of the foul gasses of putrefaction."

I take this clause to indicate the trend in practice with regard to the modes of disposal of 1401
sludge referred to in this book, but I wish to add that at this time I am not positive that there is not some statement in the said book to the effect that any advantage could be obtained by the decomposition or putrefaction of the sludge in the tank. The affecting of solids in suspension by the putrefactive action is mentioned in several 1402
places in the book, and it may be, upon further examination of said book, that the putrefaction of sludge in the tank may be mentioned in connection with the advantage of the action, but I think not.

XQ. 121. Are the following excerpts from the Rafter & Baker book of 1894, commencing page 1403
207:

"METHODS OF SLUDGE DISPOSAL.

"Practiable methods of disposing of sludge may be classified as:

(1). The sludge may be allowed to flow or may be pumped into sludge basins, from which it is subsequently conveyed, either by gravity or steam power, to adjacent areas, to be utilized as an agri- 1404
cultural fertilizer.

(2). The sludge may be deposited in large open basins, surrounded by embankments, where it is allowed to remain until the larger portion of the water has evaporated or drained away, after which it is removed by carts or other coveyance, either for use as a fertilizer, or to some other point for final disposal, as in filling in low land. .

(3). Liquid sludge may be run directly on to agricultural areas, and efficiently disposed of by ploughing into the soil as soon as possible.

(4). Sludge, either in the liquid state or after partial desiccation, may be mixed with combustibles, such as peat, tanbark, and sawdust, and disposed of by burning.

1406 (5). Sludge may be mixed with earth, rubbish, vegetable mold, marl, gypsum, stable manure, leaves, or other suitable materials, to form compost heaps, and in this manner finally utilized as manure.

(6). Liquid sludge may, when disposal works are situated within reach of a large and deep body of water(and for this purpose tide-water is preferable), be disposed of by running into dumping
1407 scows which convey it to deep water where it may be dumped. The minimum distance at which this operation may be safely performed in large bodies of fresh water, like the great lakes, which are also the source of public water supplies, is as yet entirely unknown.

(7). Sludge may be burned in a furnace of form similar to a garbage destructor, or in a garbage destructor in connection with garbage, as at Coney
1408 Island, N. Y.

(8). Sludge may be compressed by a filter press into solid cakes, in which form it may be handled and conveniently transported for use as a fertilizer.

"The use of the filter press has considerably simplified the handling of sludge, which, previous to its introduction, was a source of great difficulty at nearly all precipitation works. At present filter
1409 presses are in use at only two places in this country, namely, at East Orange and at Long Branch. For a statement of some of the results at East Orange, the reader is referred to Chapter XXIV., treating of the works at that place.

"Sludge, as it ordinarily comes from settling tanks, operated by either the intermittent or continuous system, contains from 90 to 95 per cent. water and from 5 to 10 per cent. solid matter."

 1410

Also, on page 204:

"CONDITIONS ESSENTIAL FOR SUCCESS.

"(4). That the arrangements for removing the sludge be such as to insure its frequent removal, for if left in the tanks until putrefaction sets in the sludge is likely to rise to the surface, giving off foul odors."

A. Yes. 1411

XQ. 122. I understand the following to be excerpts from Waring's book on "Modern Methods of Sewage Disposal," 1894 Edition. We have not that Edition here present, but I will ask you to verify these excerpts and report as to their accuracy at a subsequent session.

On page 12: 1412

"In practical work, two cardinal principles should be kept in view and should control our action:

(*a*) *Organic wastes must be discharged at the sewer outlet in their fresh condition—before putrefaction has set in; and*

(*b*) *They must be reduced to a state of complete oxidation without the intervention of dangerous or offensive decomposition.*" 1413

On page 57:

"THE PREPARATION OF SEWAGE FOR TREATMENT.

. . . .

"The coarser constituents, or such of them at least as will not be broken up in the earlier stages of disposal, should be removed by screening. To 1414
remove them by sedimentation in tanks, as is not unusual, leads to putrefaction, and is not admissible in good work. Horizontal screens where the conditions admit of their use are better than vertical ones as they are more easily cleared of their accumulations and are more complete in their action. After screening the sewage will still contain a good deal of suspended matter, fibrous and

other, which constitutes sludge in the case of precipitation, and which is an embarrassment in irrigation and still more in filtration. It should be removed as completely as possible in the work of preparation.

. . . .

"As a matter of fact, such preparatory treatment opens a field for invention and improvement
1416 that is well worth exploiting."

A. I will do so.

XQ. 123. I now turn to some of the text-books in this art written and published subsequent to the introduction of the knowledge of Cameron's septic tank system at Exeter, England.

Is the following an excerpt from the book en-
1417 titled "Sewage and the Bacterial Purification of Sewage," by Samuel Ridel, Fellow of University College, London; Fellow of the Institute of Chemistry, of the Chemical Society, and of the Sanitary Institute of Great Britain; Vice-President of the Society of Public Analysists; published in 1891; page 203:

1418 0 "In 1895 Mr. Cameron, City Purveyor of Exeter, introduced his 'septic tank' process for the treatment of a portion of the sewage of the city, comprising about 1500 to 2000 persons on the combined system, with a volume of approximately 50,000 gallons. The tank is cemented water-tight, and banked below the ground to keep it from changes of temperature, the top being arched over
1419 and covered with turf, so that light and air are excluded. The raw sewage, without screening or any preliminary treatment, enters by two inlets which are carried down five feet below the surface in order that the entry may be quiet so as not to disturb the bacterial layers, also, that air may not be carried in, nor any gases escape back to the sewer. After passing through a 'grit chamber' 10 feet deep by 7 feet long, and of the same width as the tank (18 feet), the sewage flows over a wall

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submerged one foot below the surface into the main portion of the tank which is 56 feet 10 inches in length, 7 feet 6 inches in depth, and 18 feet wide, its capacity up to the level of the liquid being 53,800 gallons or approximately a day's supply. Hence the transit of the sewage is ordinarily very gradual, averaging about 24 hours in the tank, so as to give ample time and quiet for the changes. 1421

. . . .

"From the inspection chamber it is seen that a leathery scum from 2 to 6 inches thick, according to the position, collects on the surface and renders the whole anaerobic. Below this is a zone of fermentation, but bubbles of gas keep the liquid in a state of quiet admixture. At the bottom of the tank there is a layer of the dark peaty matter previously referred to (p. 87), which is so small in 1422
amount that during a period of one year's working it does not require to be removed. It is reported since that after three years without clearing the amount of sediment or residue from the sewage and excreta of a population of 1500 was under 4 feet deep. The insoluble organic matter has been gradually broken up by the bacteria, while the inorganic substances have been kept in suspension by the gases and have passed off in the flow so that the 1423
quantity does not sensibly increase."

A. Yes.

XQ. 124. Is the following an excerpt from the book entitled "Municipal Engineering and Sanitation," by M. N. Baker, Associate Editor of Engineering News, published in 1902, page 145:

"Within the past few years studies made in Eng- 1424
land and America have shown that the old-fashioned cesspool, dangerous as it has been oftentimes, was not wholly bad and that in those dark and ill-ventilated chambers the anaerobic bacteria have been carrying on their work unseen and unknown. By changing the form and proportion of the cesspool to an elongated tank, providing preliminary grit chambers for the deposit of sand and other

fixed mineral matter, and arranging for the continuous flow of sewage through the tanks at a very low rate the suspended organic matter has been retained to be acted on by the anaerobic bacteria at their leisure. Such solid organic matter as has passed on and out with the partially clarified effluent, has been either in the dissolved form or in
1426 a finely divided state that will readily dissolve.
Under this system the sludge in the septic tank, as this reservoir is called, accumulates very slowly owing to the fact that so much of the organic matter is changed to gaseous forms, water, and dissolved nitrogenous matter. Consequently, the sludge problem, incident to chemical precipitation and more or less troublesome in broad irrigation and intermittent filtration, largely disappears with the septic tank. The effluent from these tanks
1427 contains about as much organic matter as that
from chemical precipitation works. But in a form much more suitable for further transformation. A little aeration and it may be passed to filter beds where aerobic bacteria complete the process."

A. Yes.

XQ. 125. Is the following an excerpt from the book published in 1904, entitled "The Purifica-
1428 tion of Sewage, Being a Brief Account of the
Scientific Principles of Sewage Purification and their Practical Application," by Sidney Barwise, Fellow of the Sanitary Institute, Medical Officer of Health of the Derbyshire County Council (page 87):

"It was left, however, to Cameron of Exeter to
1429 be the first to successfully deal with the sewage of
a town by first liquefying the sewage and then oxidizing or nitrifying it on bacteria beds."

A. Yes.

XQ. 126. Are the following excerpts from the book published in 1905, entitled "Sewerage, the Designing, Construction and Maintenance of Sew-

 1430

erage System," by A. Prescott Folwell, Member American Society Civil Engineers; Member American Society of Municipal Improvement; Associate Professor of Municipal Engineering, Lafayette College (pages 4 and 13):

"It seems advisable to speak thus at length on
this subject for the reason that many intelligent 1431
persons look with favor on the cesspool as a sanitary contrivance, whereas in most cases it is one of the greatest abominations permitted in any civilized community.

. . . .

"The general adoption of the septic tank (*see* Art. 98), which has been called the 'glorified cesspool,' cannot properly be used as an excuse for the
cesspool. In reality the two differ in every essen- 1432
tial. In no satisfactory septic tank does the sewage remain longer than 24 or at most 48 hours. Even then there are given off large quantities of gases which no one would think of piping into his house as is practically done from most cesspools. A comparison of cesspools with septic tanks does not touch upon the objections to the former that its use scatters a large number of centers of soil pollu-
tion throughout a closely populated area." 1433

Also at page 423:

"The septic tank consists essentially of a rectangular tank through which the sewage flows continuously and so slowly as to permit all suspended matters to settle to the bottom or collect upon the surface, the sewage being drawn off by a horizontal slot a foot or so below the surface. The floating
matter forms a scum from two or three to thirty 1434
inches thick, which teems with bacteria. The size of the tank varies in different plants, capacity of from one-fourth to twice the sewage flow per twenty-four hours having been given. Probably the majority have a capacity of about the daily flow. It was at first thought necessary to exclude air and light from the tank by means of a roof or cover, but the experiments at Lawrence and Man-

chester have shown this to be unnecessary. It is thought desirable, however, to cause the sewage to enter the tank beneath the surface of its contents that air may be excluded; and the scum probably serves to exclude both light and air from above. The depths of the tanks which have been built varies from three and a half to ten feet. Since
1436 the scum may occupy two feet or more and the sediment half this depth, it would seem desirable to make the tank at least five feet deep and probably six or eight feet would be better. Too great depth or width would render it difficult to cause uniform flow throughout the tank which is essential. The areas of the tanks vary from 16 by 37 feet to 18 by 100 feet."

A. Yes.

1437 Recess.

XQ. 127. If you have access to the Journal of the New England Water Works Association, will you please ascertain and state at a future session, whether the following is an excerpt from a paper on "The Purification of Sewage by Bacterial Methods," read on or about July 2, 1901, by Dr.
1438 Leonard P. Kinnicutt, Professor of Chemistry, Worcester Polytechnic Institute:

"The real practical value of the septic tank is that it destroys suspended matter without formingany very great amount of sludge or precipitate, thus having an advantage over any chemical precipitation process; that it seems to bring cellulose into at least partial solution, thus preventing the
1439 coating over of bacteria beds, either those of intermittent filtration or contact, with a layer more or less impervious to water; that it breaks up the more complex organic compounds, forming substances that are more easily acted upon by the nitrifying bacteria than the compounds in raw sewage. In a few words, it is a process which prepares the sewage for subsequent treatment on bacterial beds, either those of the double contact sys-

tem or those of the intermittent filtration system. And if I were asked what was the most important step made in sewage treatment during the past ten years, or since the report of the Massachusetts State Board of Health, I think I would answer, the recognition that sewage purification should, for the best results, take place in two stages, and the devising of a method, as the septic tank treatment, for 1441
breaking up the complex organic compounds and bring a large part of the suspended matter in solution. Without some preliminary treatment, I feel convinced that any systems of treating large quantities of sewage on limited areas like the double contact system, is doomed to failure, and I also feel convinced that with the intermittent filtration method much more satisfactory results could be obtained if the sewage first received septic treatment." 1442

And will you also verify, if you can, the following excerpt from Professor Kinnicutt's paper, published in the Journal of the Association of Engineering Society, June 1903, page 323:

"During the past two years the septic tank has grown in favor and has been installed in a great many places in England and the general opinion is 1443
that it certainly has its place in the bacterial purification of sewage. . . . . . It prevents to a large degree the clogging of bacterial beds. It liquefies or changes into gaseous products a portion of the suspended matter at the bottom of the tank, thus reducing the amount of sludge. It renders as a rule the sewage more easily acted upon by nitrifying bacteria." 1444

A. I will.

XQ. 128. How does Professor Kinnicutt stand as an authority in this art? A. He is one of the leaders in America.

XQ. 129. Is the following an excerpt from an opinion given by you to the City of Baltimore and published in the Baltimore News of May 22, 1905:

"Baltimore would make no mistake if it installed a septic tank system, employing, for instance, sand filters for secondary treatment. Such a system would give absolute satisfaction in Baltimore, especially in view of the fact that the disposal plant there will not have to take care of storm water but will be limited to sewage proper. That simplifies
1446 the problem materially. The fact that a septic-tank-sand-filter system has never been built on a scale as large as would be necessary in Baltimore is of no consequence. The system has proved itself thoroughly capable of taking care of 2,000,000 or 50,000,000 gallons of sewage a day, provided that the plant is large enough. The only problem for Baltimore will be to build big enough septic tanks and sufficiently large filter beds."

1447 A. Said quotation in the Baltimore News purports to be an opinion given by me to the City of Baltimore. I have given no such opinion to the City of Baltimore, nor any other opinion.

XQ. 130. Do you mean to say that you did not furnish any foundation whatsoever for the publication quoted in the last question? A. The foundation for the quotation was laid in a conversation
1448 I had with a Baltimore News staff correspondent.

XQ. 131. So far as the excerpt above quoted is concerned, does it embody with substantial correctness a portion of what you said at that interview? A. Yes.

XQ. 132. Does the following excerpt from the
1449 Baltimore News article of May 22, 1905, also represent substantially what you said at that interview?

"The following table gives the rates in gallons per acre of filtering surface daily which may be maintained by the several processes.

F. HERBERT SNOW.

Kind of Sewage.	Method of Preliminary Treatment of Suspended Solids.	Type of Bacterial Filter.	Rate of Operation (Gallons) Per Acre Daily.
Fresh	No Treatment	Slow Sand	100,000
Stale	Plain Subsidence	Sand	150,000
"	Chemical Subsidence	"	200,000–360,000
"	Coke Straining	"	320,000
"	Gravel Filtration, aided by current of air	"	660,000
"	No Treatment	Spraying Coke	600,000
"	" "	Double Coke	600,000
"	Plain Subsidence	Continuous Aerobic Broken Stone	1,400,000
Septic	In Septic Tank	Sand	40,000–150,000
"	" " "	Spraying Sand	300,000
"	" " "	Contact	660,000–800,000
"	" " "	Continuous Sprinkling	1,400,000"

A. Yes, the rates in the table are for gallons per acre daily of filtering surface.

XQ. 133. When you drew the line between "staling of sewage" and "septic action" in answers 82 and 83, you defined the septic action as the "establishment of the equilibrium between the accumulated solids in the tanks plus those being constantly added thereto by the inflow of the sewage, and the bacterial activity whereby further accumulations are prevented." Was it in that sense that you employed the word "septic" as distinguished from "stale" sewage in the table quoted in the last question? A. Yes.

XQ. 134. Are the following excerpts from your Pawtucket testimony heretofore referred to, in relation to the distinction between settling tanks and septic tanks, (page 312):

"Q. 4. What is the difference between the structure and operation of settling tanks and septic tanks? A. In answering this question I understand that the term 'septic tank' refers to Mr. Cameron's tank at Exeter, England, or one like it in design or purpose, since this word was the

1455

term Cameron used to designate his
and, so far as I know, was the first ı
word as applied to sewage disposal, anı
fix the date of this use of the word, w
since become widely accepted, by the
the English patent, which was about Apri
With this understanding, the substantial
1456 ence between the two is this: That the ı
tank is a settling tank in which the suspeı
solids are retained in a constant depth of wı
for an indefinite period for the intentional p
pose of securing their dissolution by the putı
factive process, while the settling tank, perhap
exactly similar in every respect except that oı
manner of operation, is a structure in which the
settled solids are retained in the tanks for brief
periods only and are removed at short intervals
1457 and in a comparatively fresh condition. The
time that the solids are retained in the tank is
one of the essential differences. The maintenance
of a constant level of sewage in the tanks and
the continuous principle of operation as distinct
from the intermittent principle are the other essential differences."

(Page 332):

1458 "I have observed that from eight to twelve weeks may elapse from the starting of a septic tank before there is rapid evolution of gas, and during this time the solids accumulate very rapidly. A settling tank, operated simply as a settling tank, that is, requiring the drawing off of the accumulated sludge every few days, prevents the ripening of affect in bacterial growth within the tank and consequently interferes with and
1459 prevents the proper effective development of the liquefying bacteria. I do not mean to be understood as saying that substantial septic action may not be secured in less than eight weeks or more than twelve weeks, but from my observation and experience with average sewage I believe that the time will be in the vicinity of eight to twelve weeks."

(P. 383):

"The proper use of the term 'septic tank' involves its application to that apparatus in which the solids are retained for an indefinite period for the purpose of securing substantial liquefaction of the solids which have subsided in the tank by the natural action of gravity." 1461

(Page 388):

"XQ. 71. One advantage of retaining your septic tanks over replacing them by settling tanks is that you have no sludge to dispose of except at the end of long periods of time, as I understand it; is that so? A. Precisely. The prime object of the septic tank is to facilitate the handling of the sludge whose disposition in any case is the great problem. 1462

"XQ. 72. And as to the disposition of certain contents it is also an advantage of the septic tank that its functions include, as stated by the State Board of Health Report for 1900, page 371, 'the hydrolosis and transformation into gases of cellulose in sewage, such as paper, rags, vegetable matter, etc.,' is it not? A. In practice considerable of this material is not liquefied or transformed into gases and remains in the tank with 1463
mineral matters to be finally removed and disposed of, but to the extent that these matters are liquefied or gasified, it is an advantage since it reduces the amount of matter to be removed from the bottom of the tank.

XQ. 73. Another advantage of your septic tanks is that the effluent, as you say in answer to Q. 69, 'imposes less work upon the oxidizing bed?' A. Yes. 1464

"XQ. 74. Is it also an advantage of your septic tank that the secondary beds work equally well in summer and in winter? A. The oxidizing beds of our plants do not effect as thorough nitrification in winter as in summer, so they do not work equally well, but the said oxidizing beds undoubtedly work better in winter than they would were not the suspended solids of the sew-

age partially intercepted in the septic tank and
partially liquefied and gasified therein.

‘‘XQ. 75. It is also an advantage of your sep-
tic tanks, is it not, that its effluent has less con-
tents requiring mere straining than the effluent
of settling tanks would have—I refer to strain-
ing as contradistinguished from oxidation as re-
1466 ferred to by you in answer to Q. 7? A. Yes.’’

A. Yes.

XQ 135. Using the term “septic tank” in the
sense in which you used it in the above quotations
from your testimony, and using the term “septic
action” substantially as you have defined it in your
answers 82, 83 and 133, namely: the “establishment
of the equilibrium between the accumulated solids
1467 in the tank plus those being constantly added there-
to by the inflow of the sewage, and the bacterial ac-
tivity whereby further accumulations are prevented
—using those terms with those significations, please
state all of the publications and patents in the
prior art among those referred to in any part of
your testimony, wherein you allege that such “sep-
1468 tic tank” or such “septic action” was described?
A. I understand this question as not relating to
apparatus, but rather to the intentional use of
substantial septic action in tanks, and I answer
accordingly: German patent, No. 9792 of 1878, to
Alexander Muller; French patent, No. 144,904, of
1881, to Louis Mouras; U. S. patent, No. 268,120, to
1469 L. Mouras, Nov. 28, 1882; British patent, No. 5391 of
1881, to William R. Lake, (this British patent, No.
3203 of 1868, being the Britsh Mouras patent), to
Gavin Chapman; British patent, No. 1706 of 1870,
to Bevan G. Sloper; British patent, No. 7134, of
1887, to Wilhelm Gurtler; U. S. patent, No. 258,-
744, of 1882, to Amasa S. Glover; U. S. patent, No.

 1470

424,838, April 1, 1890, to F. L. Union, (as applied in practice at Milford); U. S. patent No. 530,622, Dec. 11, 1894, to W. D. Scott-Moncrieff. Dibdin's Report to the London County Council, Oct. 1895, describing his Sutton contact filter tanks. Description of Alexander Muller's experiments. Transactions of the Journal of Society of Arts. Translation of Mouras' French patent, and in reference to 1471
Mouras' apparatus, Vol. XLVIII, 1882, page 50, Vol. LXXII, 1883, page 359, and Vol. LXXVIII, 1884, page 502, of the Minutes of Proceedings of the Institute of Civil Engineers and Engineering News, April 15, 1882, and Professor L. Pagliani's paper before the International Congress of Hygiene at 1472
London, 1891.

Extracts of British Press Publications, with respect to Scott-Moncrieff's Process.

From Waring's books, as follows:

His 1876 book, with respect to a grease trap and tight cess-pools.

In his 1891 book, entitled "Sewerage and Land 1473
Drainage," page 287, page 288, and 291.

In his 1894 book on "Modern Methods of Sewage Disposal," page 216, 218.

Catalogue, entiled "Flush Tank Company, Chicago," 1892, page 24 and 26.

Sanitary Engineer, May 10, 1883, describing Phillbrick's apparatus. 1474

19th Annual Report of the Massachusetts State Board of Health, for 1887, pages 100 and 101 and 102.

Transactions of the American Society of Civil Engineers, February, 1887, describing tanks at Lawrenceville, N. J.

1475 F. HERBERT SNOW.

Rafter & Baker's book page 507, describing the tank at the Massachusetts School for Feeble Minded.

British patent, 3312 of 1890, to Adeney & Parry.

I believe the above list to answer the question, but possibly I may have overlooked some instances.
1476 In the above references, hereinbefore, I have fully described what they comprise, the said descriptions appearing on the record.

Adjourned to Monday, June 26th, 1905, 10:30 A. M.

New York, June 26th, 1905, 10:30 A. M.

Met pursuant to adjournment.

1477 Present, Counsel, as before.

Cross Examination of Mr. Snow Continued:

Since it does not apear whether the various quotations made from the prior art publications by Mr. Snow, or the copies thereof introduced in evidence are in all cases complete copies of the particular
1478 matter referred to and its context, complainant's counsel now makes a general objection to each and all of them as incomplete and fragmentary.

Complainant's counsel also objects to the quotations and exhibits of and references to the Pagliani article, on the ground
1479 that it does not appear to have been a printed publication in the sense of the statute and that its date of publication, if ever, does not appear.

Complainant's counsel also objects to the translation as to the Alexander Muller device, quoted at the beginning of answer

 1480

26, on the ground that it does not appear whether it was published prior to November 11, 1898, the date of the Journal of the Society of Arts, Vol. XLVI.

Complainant's counsel notes of record, that the Waring books of 1876 and 1894, have not as yet been produced, and therefore objects to the quotations and exhibits therefrom and references thereto, as incompetent. 1481

Defendants' counsel notes of record, a willingness to produce the books referred to and any other books desired, at any time upon reasonable notice, and states, that the reason why all books referred to by the witness have not been present during the entire examination is that the same have to be obtained from libraries and can not be kept out indefinitely, or, as a general rule, for more than one day at a time. 1482

Complainant's counsel states that he has not objected to anything which has been present at any part of Mr. Snow's deposition which appears upon its face to have been a printed publication in the sense of the statute. 1483

Complainant's counsel objects to the Catalogue of the Flush Tank Company on the ground that it does not appear to be a printed publication within the meaning of the statute, and furthermore that its date of publication, if ever, does not appear. 1484

Complainant's counsel objects to the quotations and exhibit from and the references to the "Extracts from the Press

1485 on the Scott-Moncrieff System," on the ground that it does not appear to have been a printed publication in the sense of the statute and its date of publication, if ever, does not competently appear.

Complainant's counsel objects to the
1486 quotations and exhibits from and references to the "Dibdin Report to London County Counsel," on the ground that the publication in which it appears does not appear to have been published until 1902. This objection holds good also as to all other quotations and exhibits from and
1487 reference to the publication entitled "The Interim Report of the Commissioners Appointed in 1898 to Inquire and Report what Methods of Treating and Disposing of Sewage may be Properly Adopted."

XQ. 136. After the adjournment over Sunday, do you wish to add to the references given in
1488 answer to the last question? A. I have given no further consideration to the matter during the adjournment.

XQ. 137. If you desire to add any reference in answer to XQ. 135, to those already contained in that answer, please do so now. A. I think I have nothing further to add.

1489 XQ. 138. For the convenience of the Court I desire to have a list of the references cited by you in answer to XQ. 135, arranged in such a way that the various references descriptive of the same apparatus or process or inventor, are arranged together, and I have therefore prepared the following list in which the apparatus or process is identified in the first column by the inventor or locality and the publications that you have referred to for showing it are in the second column.

Mouras	U. S. 268, 120 of 1882.	
"	English 5391 of 1881.	
"	French 144, 904 of 1881 & Translation.	
"	Minutes Inst. Civ. Eng. XLVIII.	1491
"	" " " " LXXII.	
"	" " " " LXXVIII.	
"	Engineering News, Apl. 15, 1882.	
Pagliani	Congress of Hygiene, etc.	
Muller	German 9792 of 1878.	
"	Journal Soc. Art. of 1897.	
Waring	1876 Edition p.	
"	1891 Edition pp. 287-291.	
"	1894 Edition pp. 216-218.	
Phillbrick	Sanitary Engineer, May 10, 1883.	
Medfield	Mass. Bd. Health Report 1887, p. 100-2.	
Feeble Minded Sch.	Rafter & Baker, 1894, p. 507.	1492
Lawrenceville	Am. Soc. Civ. Eng. Feb. 1887.	
Scott-Moncrieff	U. S. 530, 622, 1894.	
" "	Extracts Press- Pamphlet.	
Dibdin	Rep. to Lon. Co. Council.	
Union	U. S. 424, 838 of 1890.	
Glover	U. S. 258, 744 of 1882.	
Adeney	English, 3312 of 1890.	
Chapman	English 3203 of 1868.	
Sloper	English 1706 of 1870.	
Gurtler	English 7134 of 1887.	
Flush Tank Co. Catalogue.		

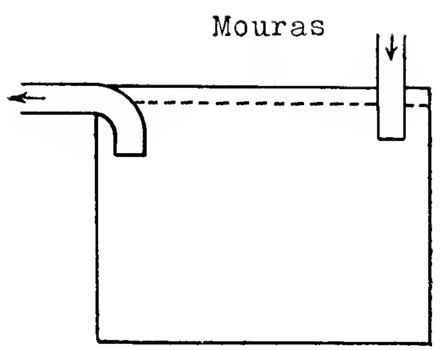
A. The list is correct. 1493

XQ. 139. I observe that when you gave the list in answer to XQ. 135 you hesitated about inserting Lawrenceville. Why was that? A. Because there is nothing in the Lawrenceville article that says in so many words that there was an intentional use of septic action. 1494

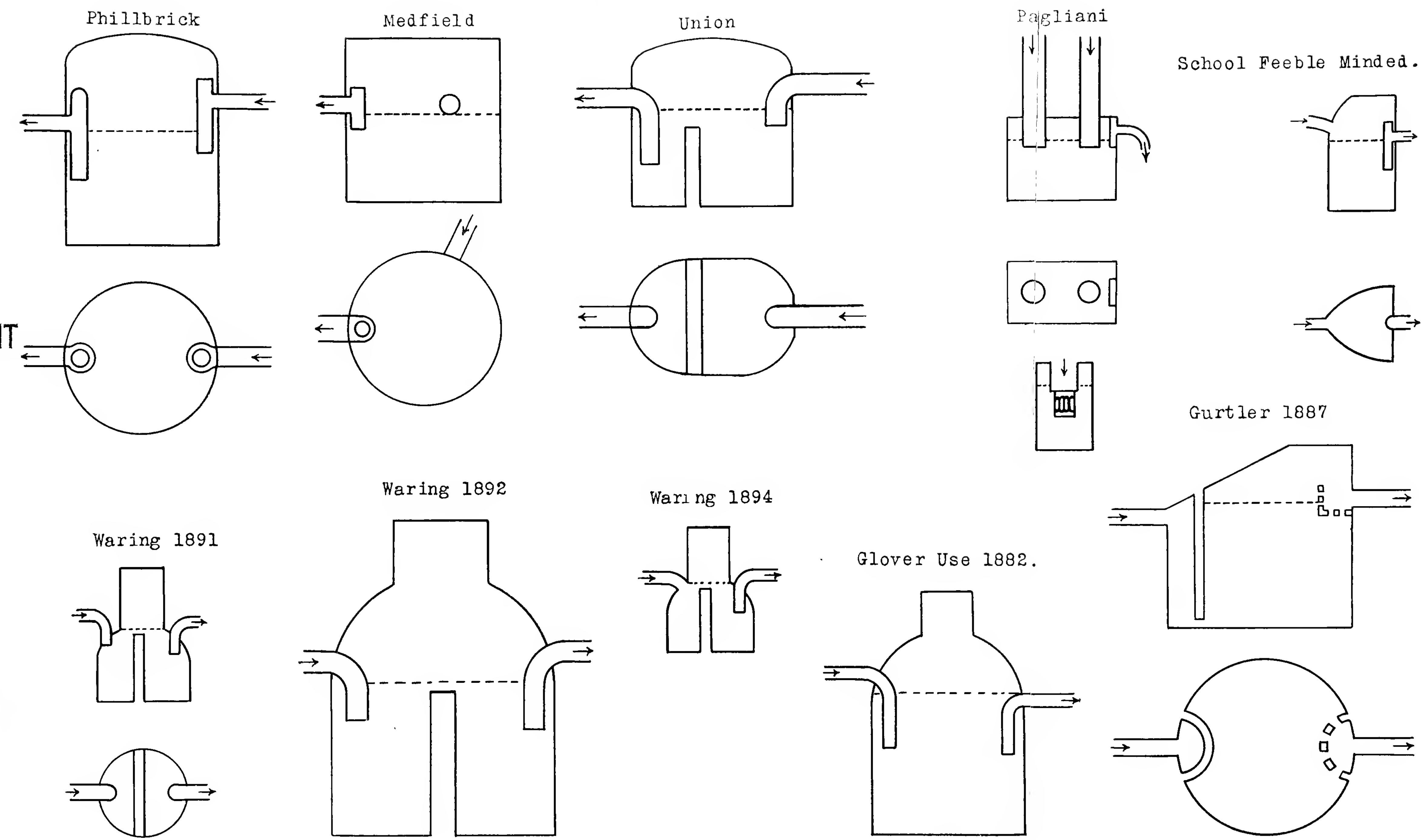
XQ. 140. In which of the publications and patents cited by you in answer 135 is the tank that you now refer to as being a septic tank designated by the term "cesspool?" A. In Mouras French, English and United States patents; in Phillbrick article in the Sanitary Engineer, in the Medfield plant, the Union patent, and possibly in Waring's publications.

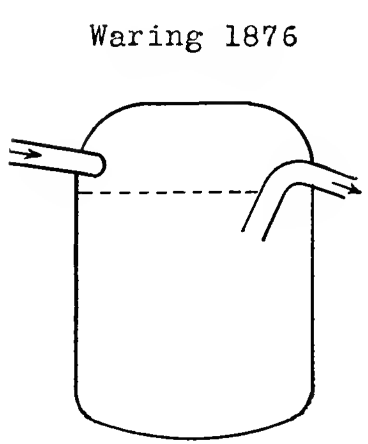
XQ. 141. Do you find any substantial difference, so far as the questions here involved are concerned, between the different illustrations that you have introduced, or that are shown in
1496 the publications which you have referred to, of the Mouras apparatus? A. There are slight differences, but the United States patent shows everything that is included in the others, so far as drawings are concerned.

XQ. 142. I desire now to serve the convenience of the Court by collecting together tracings of
1497 the inner lines and the outlets and inlets only of the cesspools you have referred to in answer 140, namely, Mouras, Phillbrick, Medfield, Union and Waring, also your "sketch of Glover's cesspool." I will ask that you point out to me on the drawings the structure in each of these cases that you treat as being the septic tank, so that I may make such tracings, and can indicate on each trac-
1498 ing also the water level by a dotted line. A. In reference to Mouras, I point out Figure 1 of the United States patent. In reference to Phillbrick I point out the drawing accompanying the article in the Sanitary Engineer, page 554, May 17, 1883, entitled "Siphon Tank." In reference to
1499 Medfield, I point out the drawing entitled "Cesspool," Plate III., State Board of Health Report, Massachusetts, 1887. In respect to Union, Figure 1 in the drawing of U. S. Patent No. 424,838, April 1, 1890; and in respect to Waring, in his 1896 book, Figure 14, page 195, entitled "Grease Trap" and in his 1891 book, page 291, Figure 56, entitled "Arrangement of Flush Tank and Ap-



Complainant's Exhibit
Tracings Prior Art Cesspools





pliances,'' and in the Flush Tank Catalogue, 1892, page 24, Figure No. 1, entitled ''Intercepting Chamber,'' and in Waring's 1894 book, page 217, Figure 5, entitled ''Settling Chamber.''

Recess.

XQ. 143. Have I in accordance with the statement of the last answer made the tracings with 1501
substantial accuracy? A. Yes.

Complainant's counsel offers in evidence the sheet of tracings last referred to, and the same is marked ''Complainant's Exhibit Tracings Prior Art Cesspools.''

1502

XQ. 144. I would like to add on the sheet of tracings just offered in evidence, a corresponding tracing of the Pagliani construction which you have treated as being a septic tank. Can you point out to me a drawing which you understand to represent this Pagliani construction, from which I can make such tracing? A. On Plate
XL. Trans Am. Soc. Civ. Engrs. Vol. XLVI. No. 1503
909, which accompanies Metcalf's paper on ''The Antecedents of the Septic Tank,'' September 25, 1901, there is a drawing entitled ''Of L. Pagliani, Rome, Italy, 1884, 1891, Fig. 7.''

The tracing above referred to is added to the Exhibit sheet and marked 1504
''Pagliani.''

XQ. 145. In order that I may add it also to the sheet of tracings above marked in evidence, will you please point out in the drawings of Rafter & Baker of the apparatus at the Massachusetts School for Feeble Minded that portion which you

1505 have treated as corresponding with the septic tank? A. I now point out on page 508 of said book, Fig. 89, entitled "Details of Detaining Tank," &c., that part thereof marked "Sludge Trap."

The tracing referred to in the last
1506 question is added to the exhibit sheet and marked "School for Feeble Minded."

XQ. 146. In order that I may add it also to the sheet of tracings above marked in evidence, will you please point out in the drawing of the Gurtler English patent 7134 of 1887, that por-
1507 tion which you have treated as corresponding with the septic tank? A. It is Fig. 7 in the drawing of said patent, which I now point out.

The tracing referred to in the last question is added to the Exhibit sheet and marked "Gurtler, 1887."

XQ. 147. Which of the tracings on the sheet
1508 marked "Complainant Exhibit Tracings Prior Art Cesspools" in your opinion represents the nearest approximation to the septic tank shown in the Cameron patent in suit? A. Pagliani first, Gurtler second, and together in one group, Mouras, Philbrick, Union, Glover, Waring 1891 and 1892, third; and together in a group, War-
1509 ing of 1876 and 1894; Medfield, School for Feeble Minded, fourth. I place Pagliani first because, as I understand the drawing, there is a non-disturbing outlet consisting of a conduit extending the whole width of the tank and having an opening disposed throughout its length beneath the normal water level of the tank and above the bottom

of said tank, and having also two non-disturbing inlets disposed above the bottom and below the normal water-level of the tank. I take Gurtler as second, because it shows an inlet consisting of a conduit extending for a part of the width of the tank, and having an opening the entire width
thereof below the top or water-level and above 1511
the bottom, but extending to the bottom of the tank, and also an outlet comprising as chamber or conduit disposed in the tank and extending a part of the width thereof, having a series of openings in the bottom and side thereof, said openings being below the normal water level in the
tank and above the bottom of said tank. I group 1512
Mouras, Philbrick, Union, Glover and Waring of 1891 and 1892 as third because they each comprise a non-disturbing inlet and outlet consisting of a pipe extending in the tank and turning downward, having its opening below the normal water-level thereof and above the bottom of the tank for the purpose of admitting the liquid and
also drawing it out of the tank without disturb- 1513
ing the surface scum or the deposits in the tank. I have cited Waring of 1876 and 1894 and Medfield and the School for Feeble Minded, as fourth because in each the inlet pipe is above the normal water level of the tank, but the outlet thereof extends below the said normal water level and
above the bottom of the tank, the purpose of said 1514
outlet being to draw the water from mid-depth and thus prevent the passage of floating matters or deposits from passing out with the liquid.

XQ. 148. In your quotation from the Pagliani article in your direct testimony, what is his description of the outlet which, in your last answer

1515 you have described as a ''non-disturbing outlet consisting of a conduit extending the whole width of the tank and having an opening disposed throughout its length beneath the normal water level of the tank and above the bottom of said tank.'' A. In my answer to Q. 26 I quoted as
1516 follows from Pagliani's description:

''As in every Mouras reservoir, mine has for overflowing liquids an opening, but provided with a grate, through which can not pass directly those bodies that are floating on the liquid gathered in the reservoir. This opening has the diameter a little less than 5 centm., that is to say, narrower than that of the tube which begins from it, and continues in other still larger ones, so that
1517 what passes through it will surely pass through the next tube.''

I understand the drawing in ''Complainant's Exhibit Tracings Prior Art Cesspools'' shows this opening aud also the grate ''through which can not pass directly those bodies that are floating on the liquid gathered in the reservoir.'' This
1518 grating is shown as extending across the width of the tank and below the normal water level thereof and comprises what I described in my last answer as ''a non-disturbing outlet consisting of a conduit extending the whole width of the tank and having an opening disposed throughout its length beneath the normal water level of
1519 the tank and above the bottom of said tank.'' I should perhaps add these words, ''having an opening or series of openings disposed throughout its length.''

XQ. 149. What are 5 centm. equal to in inches? A. About two inches.

XQ. 150. Since the Pagliani drawing seems to

me too ambiguous, unaided by further description, and since no publication of either the drawing or the description yet appears prior to the Cameron patent in suit, I will pass to the second of the tracings mentioned in your 147th answer, namely, Gurtler. Please quote from the Gurtler English patent the whole reference made to this 1521
drawing in any way, whether as to its construction or mode of operation. A. On page 2, line 18:

"Fig. 7 shows a section of a pit for water-closets, &c."

On page 3, line 37:

"Pits may be constructed as shown at Fig. 7 1522
of the drawings accompanying my Provisional Specification, being entirely closed with hermetically closed openings and be provided with pumps for emptying their contents without requiring to be opened.

"Such structures, while affording the requisite strength, will also have a certain degree of elasticity and will be exceedingly cheap and durable and at the same time easily and quickly made." 1523

On page 4, line 18:

"Figure 7 shows a section of a pit for water-closets, &c."

These are the only references I find in the patent.

XQ. 151. In the Gurtler description do you find any authority for locating the water level at 1524
the top of the outlet pipe instead of at the bottom thereof, as it is located by the dotted line in "Complainant's Exhibit Tracing Prior Art Cesspool?" A. Yes, the outlet conduit is represented in the drawing as containing stones or other material representing what I understand to be a

screening or filtering material and therefore I understand that this forms an obstruction to the flow of the liquid out of the tank, the sides of the outlet conduit chamber and the straining material it contains acting as a barrier for the scum which collects on the top of the normal water level in
1526 the tank, indicated by the dotted line which said dotted line is level with the bottom of the top opening in said outward conduit. The bottom of the said conduit is provided with openings beneath the surface of the normal level of the water and disposed at such a depth as to draw the water from below the scum and deliver it into
1527 the pipe. I therefore see no inconsistency in the dotted line representing the water level in Complainant's drawing.

XQ. 152. Is there any statement in the Gurtler specification as to what this dotted line in the Gurtler drawing was intended to represent? A. No.

1528 XQ. 153. You have stated that the inlet in Gurtler extends to the bottom. The inlet would therefore be in the sludge? A. No; because the bottom of the tank is given a very pronounced pitch away from this inlet to the opposite side, where there is disposed a pipe not shown in complainant's drawing, for the purpose of removing
1529 the sludge there accumulated.

XQ. 154. What do you understand to be the meaning in the Gurtler drawing, Fig. 7, of the dotted line near the bottom? A. This shows the level line, below which the outlet pipe for the sludge is disposed in the tank.

XQ. 155. Do you find any statement to that ef-

 1530

fect in the Gurtler specification? A. No; I was simply referring to the fact as to the drawing.

XQ. 156. Turning now to the group including the Mouras, Phillbrick, Union, Glover and Waring, of 1891 and 1892, which you have placed third in your 145th answer, and taking Phillbrick as the representative of this group, what size of diameter 1531
would you make the Phillbrick tank if you were going to substitute it and its inlet and outlet openings in the Saratoga plant, here claimed to infringe, in place of each of the septic tanks at present in that plant; for the same amount of sewage that is handled by the Saratoga septic tank? A. The diameter of the tank would be about 80 feet. 1532

XQ. 157. And what would be the diameter respectively of the inlet and outlet pipes? A. 12 inches.

XQ. 158. What depth of sewage contents in the tank? A. The same as in the present Saratoga tanks, about an average of 8 feet.

XQ. 159. The Phillbrick drawing appears to show
the depth of the contents as about three-quarters of 1533
the diameter, assuming this relationship of depth to diameter, how much would it reduce the diameter of 80 feet given in your 156th answer, and increase the depth of 8 feet given in your last answer? A. As I understand the question, I answer that a depth of 8 feet would require a tank
10.66 feet in diameter, where the ratio between the 1534
depth and width was 3 to 4; and in a tank 80 feet in diameter, where the ratio was the same, the depth would be 60 feet.

XQ. 160. That is not the way that I intended to put the question. I understand that you have stated that for a sewage contents corresponding with

1535 that of either of the Saratoga septic tanks, the depth of the sewage for a Phillbrick tank of 80 feet in diameter would be about 8 feet. What I want to know is, for the same sewage contents, what would be the diameter and depth of sewage of the Phillbrick tank, providing the depth of the sewage was
1536 three-quarters the diameter of the tank; as it appears to be shown in the Phillbrick drawing? A. I understand the question to refer to the Phillbrick tank dimensions as proposed by Mr. Phillbrick, for the use of an individual suburban residence. Taking these same dimensions of diameter and depth, which Phillbrick suggested for the individu-
1537 al surburban residence, of a depth of three feet to a diameter of four feet, and applying them to a tank circular and having the contents equivalent to the contents of one of the Saratoga tanks, said circular tank being 80 feet in diameter, the depth thereof to correspond to the proportions of the Phillbrick tank proposed for an individual surburban residence, would be, 60 feet.

1538 This dimension tank would hold nearly eight times more than a Saratoga tank. A tank of similar proportions to the one recommended by Phillbrick for a suburban residence of equal capacity with the Saratoga tank, would have a diameter of about 42 feet and a depth of about 31 feet.

1539 XQ. 161. Are the following excerpts from Santo-Crimp's book of 1890:

Quoting fro mthe Conclusions of the Committee appointed by the Local Government Board in 1875, to inquire into the various methods of sewage disposal, (p. 17):

"That the retention * * * * of refuse and excreta * * * in cesspools * * *

 1540

or other places in the midst of towns must be utterly condemned and that none of the so-called dry-earth or pail system or improved privies can be approved other than as palliative for cesspits-middens."

Quoting from the Conclusions of the Committee Appointed by the Society of Arts in 1876 to inquire into various subjects connected with the health of 1541
the town, (p. 19):

"That all middens, privies and cesspools in towns should be abolished by law, due regard to the point of time being had to the condition of each locality."

(P. 34):

"The pail system has been evolved from the old midden and cesspool systems regarding the evil effects of which latter the Blue Books Official Reports, issued from time to time since the 1542
date of Chadwick's first researches, give numberless examples. It is unnecessary to enter into the details of such an abominable system conservation of foul matters since it is universally condemned by all sanitarians. As an example of the enormous mass of pollution at one time existing in the large northern cities, Manchester may be quoted, where, in 1868, no fewer than 60,- 1543
000 open middens and cesspools, covering an area of sixteen acres, were in existence. The abolition of these centers of infection and disease and the substitution of pan or pail or improved closets has led to an improvement in the health of the people of inestimable value."

A. Yes.

XQ. 162. Will you examine Waring's book of 1544
1894, and state whether the following is an excerpt therefrom:

(p. 214):

"Until twenty years ago the out-of-sight out-of-mind system—in other words, the use of cesspools—was nearly universal. The radical objections to the cesspool had already begun to be recognized and they are now known to be absolutely condemnatory. Cesspools are always objectionable and there are not many cases where they are at all admissible."

A. I will.

XQ. 163. Does Waring's book of 1891 contain a
1546 chapter on "Sewage Disposal," and another separate chapter on "House Drainage?" A. Yes.

XQ. 164. In which chapter does the Waring 1891 construction occur that you have referred to in your testimony? A. It is in Chapter XXVII, entitled "House Drainage," section, entitled "The Disposal of the House Wastes."

XQ. 165. And is the first paragraph of this sec-
1547 tion as follows:

"If a sewer is available for connection with the main drain of a house the question of disposal, so far as the occupant of that house is concerned, is settled. By far the larger majority of houses, however, are without such facilities and it is a matter of the greatest importance to decide wisely as to the means of disposal to be adopted. All
1548 competent authorities are in full accord as to the pernicious character and absolute inadmissibility of cesspools or of any form of receptacle of the water-borne wastes of houses which are not subject to constant or frequent renewal."

A. Yes.

XQ. 166. What is the difference, so far as containing oxygen is concerned, between the house
1549 waste from the main drain of the house and the sewage at a sewer outlet? In other words: After the house wastes have left the main drain of a house and entered the sewer, what effect is produced upon them by passing through the sewer? A. The discharge from the house drain is what is called fresh sewage and contains dissolved oxygen. The dis-

 1550

charge from the main sewer of a large system of sewers is not fresh, but stale; that is, it contains no free dissolved oxygen, it having been consumed by those bacterial processes known as decomposition and putrefaction. The suspended matters reaching the sewer from the house are acted upon mechanically, chemically and bacteriologically as they pass 1551
along through the sewer.

Adjourned to Tuesday, June 27th, 1905, 10:30 A. M.

New York, June 27th, 1905, 10:30 A. M.

Met pursuant to adjournment.

Present, Counsel as before.

Cross Examination of Mr. Snow Continued: 1552

The witness, Snow having produced today, the 1896 Edition of Waring's book, entitled "Modern Methods of Sewage Disposal," and neither side having been able to obtain a copy of the 1894 Edition up to the present time, it is stipulated that it be assumed unless the contrary shall appear, 1553
that the 1894 and 1896 Editions are substantially identical.

XQ. 167. Did you testify as follows in the Pawtucket case, (p. 324):

"The water before receiving the foreign matter, or even afterwards, and for a time after having 1554
entered the sewer, usually contains free oxygen and nitrous and nitric acid and the organic matters are largely in suspension; but as this fresh sewage flows along, it is acted upon by various mechanical, chemical and bacterial forces, and worked over until it has undergone a distinct change, or practically the first stage in the breaking up of the organic matter into simpler forms.

Under bacterial influences in the presence of oxygen, some of the carbonaceous matter is oxidized, and the nitrogen and hydrogen unite to form ammonia, and this unites with carbonic dioxide to form ammonium carbonate, and this process will go on and on, the free ammonia increasing and the crude organic matter decreasing until the dissolved
1556 oxygen in the sewage is exhausted. Up to this stage the process is considered one of oxidation, that is, while putrefaction to some extent may, and probably does, go on in small particles of organic matters in the sewage, the principal bacterial changes and the absorption of oxygen are caused by the aerobic bacteria. The sewage is fresh or stale up to the point of exhaustion of its free oxygen; after this, bacterial life continues active in the sewage and chemical changes go on, breaking
1557 up the organic matter, but the process is a putrefactive one instead of that of oxidation, the oxygen being all absorbed and the sewage becoming foul in odor on account of the generation and escape of hydrogen compounds of carbon. Nitrogen is also set free in the putrefactive process, which process also reduces the amount of carbonaceous and nitrogenous matter in the sewage. When sewage is in this dissolving, liquefying state, it is called septic
1558 sewage, which is another name for putrefaction. The class of bacteria accomplishing this change are called anaerobic.

"Therefore the aerobic bacteria are the oxidizing bacteria, commonly spoken of in sewage purification as the nitrifying bacteria, and the anaerobic bacteria are the putrefactive bacteria and their activities are usually manifested by foul odors in
1559 contradistinction from the oxidizing bacteria, which process is generally non-offensive. The effect of complete aerobic action of organic matter in sewage is its nitrification; the effect of putrefactive or anaerobic action is largely the reduction of solid matters to liquid or gaseous form, in other words, decomposition is the term covering the whole process of changes in matter from organic to mineral form and it may be accomplished en-

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tirely by aerobic bacteria, or by aerobic and anaerobic or putrefactive bacteria, but never by the putrefactive or anaerobic bacteria alone."

A. Yes; but I notice a wrong use of the word "stale" which I should like to correct, because it was not what I meant in the said quotation and is not consistent with all my other uses of the word 1561
stale in the said Pawtucket case. In the above quotation it appears that I stated,

"The sewage is fresh or stale up to the point of exhaustion of its free oxygen."

This distinction I did not intend to make and it cannot be made now. Sewage is fresh up to the point of exhaustion of its free oxygen, and stale 1562
thereafter, and as showing that this was always the use of that word in the Pawtucket case I will refer to page 329 thereof:

"Since in fresh sewage the organic matters in suspension are larger in size, they may be strained out readily on the surface of the filter and when dry may be easily removed; this sludge does not putrefy and create a nuisance; but if the sewage 1563
be stale or putred . . . But if the quantity of stale sewage is applied in proper doses, the sludge does not seriously clog the filter, and because the organic matter has been worked over into forms more suitable for bacterial food than is the case with fresh sewage, there is greater efficiency in aerobic action in the filter. So staleing of sewage is resorted to as one means of facilitating the nitrifying of bacteria." 1564

On page 331:

"It has been observed that oxygen is absorbed slowly by fresh sewage and rapidly by stale and septic sewage, and it is known that the rapid absorption is caused by gases rather than bacterial action.

On page 332:

"Refuse matters entering the sewer are at once started on their way of decomposition by the co-operation of bacteria and the free dissolved oxygen. The rapidity of the action varies with the number and kind of bacteria present, the quality of the sewage and the temperature. Many of the
1566 bacteria are capable of growing in the absence as well as in the presence of oxygen and they are called facultative anaerobe. After the oxygen is consumed, they and the anaerobes proper continue to work and reduce the suspended organic matter."

On page 333:

"If the sewage is stale before going into the tank, it may by further anaerobic action develop various toxins."

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On page 386:

"I understand that the kind of sewage referred to here is what is known as stale sewage, that is, one in which the aerobic bacteria have ceased to work and the putrefactive or anaerobic organisms are active."

On page 388:

1568 "XQ. 70. Stale sewage is sewage in which putrefaction has commenced and proceeded to a certain degree, is it not? A. Yes."

XQ. 168. In your Pawtucket testimony, did you also testify (p. 325), as follows:

"The term decomposition, as applied to aerobic action, usually implies changes going on in an ample supply of oxygen, and the term putrefaction
1569 implies the changes going on in the absence of oxygen."

A. Yes.

XQ. 169. As I understand you, the only bacterial action which can take place so long as the free oxygen remains in the sewage is aerobic, and that the anaerobic or septic action can not commence until after the free oxygen has been disposed of; is that correct? A. No, as more particularly explained in my answer to question 28 and question 29. But, generally speaking, that is, referring to these actions, aerobic and anaerobic, in their extremes, my answer to the above question would be yes. 1571

XQ. 170. I see that in the part of your direct testimony you mentioned you refer to three dominant opinions on this subject. Everybody agrees, however, that the presence of free oxygen is inimical to anaerobic or septic action, and that so long as it remains in the sewage the aerobic action continues; is that so? 1572

A. Yes, so far as the aerobic action continues so long as oxygen remains in the sewage, and yes also, insofar as free oxygen is inimical to anaerobic or septic action, but no, insofar as the presence of free oxygen in the upper layers of sewage in a pool prevents or is inimical to anaerobic or septic action taking place in the lower or 1573
bottom layers of a pool of sewage. I mean by this that septic action may take place in the deposits in the bottom of a sewage pool to a very substantial degree, and at the same time dissolved oxygen may be present in the upper layers of that same sewage pool.

XQ. 171. Is the decomposition by aerobic ac- 1574
tion which occurs in the presence of the free oxygen attended by any maceration or breaking up of the larger solid portions of the house-waste after entering the sewer from the house drain? A. Yes. But this I believe to be very largely a mechanical and chemical action, such as is in-

1575 duced by dilution and mechanical mixing through the velocity of flow in the sewer.

XQ. 172. Is the following a substantially correct statement of the history of house-wastes from the time they leave the house drain and enter the sewer?

1576 1. The house-wastes on leaving the house drain and entering the sewer contain free oxygen.

2. As they flow through the sewer they are acted upon by various mechanical, chemical and bacterial forces and worked over until they have undergone a distinct change or practically the
1577 first stage in the breaking up, decomposition or maceration of the organic matter into simpler forms. During this stage the process is considered one of oxidation, that is, while putrefaction to some extent may, and probably does, go on in small particles of organic matters in the sewage, the principal bacterial changes and the absorption of oxygen are caused by the aerobic bacteria.
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3. In the next stage bacterial life continues active in the sewage and chemical changes go on. But the process is in this stage a putrefactive one instead of that of oxidation, the sewage being in a dissolving, liquefying state called "septic sewage," and a class of bacteria at work
1579 being called anaerobic, and the solid matters being largely reduced to liquid or gaseous form.

4. The next stage is the reintroduction of oxygen whereby aerobic bacteria are for a second time brought into action and serve to oxidize or nitrify the liquefied product produced by the anaerobic bacteria during the preceding stage.

A. Yes, understanding this to be a reference to what takes place in sewage naturally from the time of its introduction into a sewer to the time it goes into a stream of water. I should have to modify the answer if the question involved any structures for the purpose of facilitating nature's process of purification. 1581

XQ. 173. Is the following an excerpt from your Pawtucket testimony (p. 429)?

"I will say that there are two kinds of scum which are markedly different in character, one being the scum found on the surface of some settling tanks and the other being the septic tank scum; the latter is quite likely to be found several inches in thicknes and of a consistency of axle 1582
grease, while the former is likely to be light and frothy and but an inch or less in thickness. And besides the septic scum is a homogeneous mass in appearance, while the scum of the settling tank is at once and easily broken up by stirring the surface of the liquid."

A. Yes.

XQ. 174. Is the following an excerpt from your 1583
Pawtucket testimony, page 409?

"I have stated that no nitrification takes place in the tank and that all the aerobic bacteria are destroyed while the sewage is passing through and that the bacteria in the effluent from the tank may be less than one-sixth of all the bacteria that were in the original sewage. But the actions which go on in the septic tank are not purifying actions.
While the solids may be largely changed these 1584
changes relate largely to the carbonaceous matters and since there is no nitrification in the tank there is no purification, because purification comprises the reduction of nitrogenous matter to mineral form and this is not accomplished in part or in whole in the septic tank."

A. Yes.

1585 XQ. 175. Is the following an excerpt from your Pawtucket testimony (p. 333)?

"The chief object of the septic tank is to help get rid of the sludge problem. The changes which go on in the tank are largely of the carbonaceous matter and not so much with the nitrogenous matter. It is the carbonaceous matter, like cellulouse,
1586 paper, &c. which principally clogs the surface of a filter. When they remain on the surface of a filter they are very slow to oxidize, but they are readily acted upon by the putrefactive bacteria in the tanks. No nitrification takes place in the tank and all the aerobic bacteria are destroyed while the sewage is passing through, and those found in the effluent are the facultative bacteria and may be less than one-sixth of all the bacteria in the sewage before it entered the tank.

1587 "Septic effluent without aeration is very difficult to filter owing, first, to the contained gases generated in the tank and liberated in the filter, which gases are inimical to the life of aerobic bacteria; and secondly, that the partially decomposed organic matter rapidly exhausts the air held in the pores of the filter, preventing thereby effective aerobic action.

1588 "It is know that the anaerobic action may be promoted to too great an extent. If the sewage is stale before going into the tank, it may by further anaerobic action develop various toxins which prevent nitrification in the filter. So while the conditions which liquefy the solids in the tank are the principal ones aimed at those occurring in the body of the liquid in the tank may be of even more importance as effecting and preventing subsequent nitrification.

1589 "It is also known that if sewage remains in the tank for several days, that is, none flowing in or out, it disturbs and retards the desired bacterial action on the solids in the tank, and that the solids will accumulate faster.

"The optimum period for the liquid to pass through the tank is unknown, but for the average sewage it is thought to be, and is probably, between

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twelve and twenty-four hours. The solids, however, must be retained indefinitely to effect substantial liquefaction."

A. Yes.

XQ. 176. Is the extent to which the anaerobic action should proceed for the best result expressed by saying that it should go to the point 1591
of (to use your words in answer 83) "the establishment of the equilibrium between the accumulated solids in the tank plus those being constantly added thereto by the inflow of the sewage, and the bacterial activities whereby further accumulations are prevented," or in other words, that the anaerobes should be sufficient to liquefy the solid matter and conversely the inflow should 1592
serve to sustain the anaerobes? A. I answer in the affirmative excluding from the question the last clause in the same, "or in other words, that the anaerobes should be sufficient to liquefy the solid matter and conversely the inflow should serve to sustain the anaerobes." And my reason is that it nowhere appears, so far as I am in- 1593
formed, that the organisms which liquefy the said accumulated solids are entirely of the distinctly anaerobic kind.

XQ. 177. As I understand it, then, you would answer the last question wholly in the affirmative if I substitute the word "organisms" for anaerobes?" A. Yes. 1594

XQ. 178. A good deal has been said as to the effect of the septic action upon the solids in the septic tank, but I understand you to have said in your testimony quoted in XQ. 175 that the conditions occurring in the body of the liquid in the tank may be of even more importance. Will you

please explain what, if any, effect you understand the septic action to have upon the liquid portion of the sewage in the tank? A. Modifications of the dissolved matters. The important changes to which I referred in XQ. 175 were particularly those producing toxins which are known to exert
1596 a retarding influence upon nitrification in subsequent filtration.

XQ. 179. Are the following excerpts from your Pawtucket testimony (pp. 326, 328, 330)?

"There are two general forms of filters, one the natural sand or gravel filter and the other the artificial contact filter. Both are intermittent in
1597 operation and have for their object the effective cultivation of the aerobic or nitrifying bacteria. In practice they are modified to meet local conditions.

"Since nitrification or reduction of nitrogenous matter to mineral form is the object of sewage purification, the conditions most favorable to the action of the aerobic organisms which produce nitrification are all essential. These are presence of oxygen, of organic matters, of moisture, of some alkali,
1598 and a temperature favorable for plant life, and they are afforded in a filter of sand or porous material.

"The mechanical separation of the sewage by straining out on the filter is but an incident favorable to the further work in the filter, where the essential conditions are slow motion over the filtering material of the sewage in thin films in contact with air.
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. . . .

"Flowing crude sewage on porous material affects a straining out of large quantities of suspended matter which if continued will clog the filter and the effluent will be as impure as the applied sewage. It is customary in practice to obviate this by applying only so much sewage as will pass through the filter and allow the screened matter to dry up or become oxidized, and with care in this respect the intermittent operation may be carried on successfully for an indefinite period.

"The capacity of a filter is determined by the amount of sewage it can purify in winter. It has been observed that the amount of clogging material stored in a filter is proportional to the sludge in the sewage applied. A concentrated sewage chokes 1601
a filter faster than more diulte sewage, so less quantity can be safely applied and the same quantity of sludge will store up faster in a filter operated at a high rate than at a low rate. A clogged surface interferes with and retards aerobic action. Sludge clogging in winter is even a more serious difficulty than in summer, and these facts, therefore make important the removal of the sludge from the sewage before it reaches the filter. This removal
is accomplished in various ways, more commonly 1602
by a settling tank. The concentrated sludge is usually applied to sludge filters or strainers and allowed to dry before removal. The supernatant sewage freed from the large amounts of clogging material is then flowed on to the regular filters and by this means more complete nitrification is secured and at high rates.

"Therefore, to promote most effective aerobic
action in a filter much attention is directed to the 1603
sludge problem. The preliminary treatment of sewage to remove sludge before filtration, is accomplished by several methods which bring into play aerobic or anaerobic bacteria, or both, either intentionally or as an incident to the mechanical process employed for the separation. These methods are chiefly plain subsidence, subsidence aided by the use of chemical precipitants, straining pure 1604
and simple, and septic action.

"Plain subsidence is very commonly employed since large filters of fine material can be operated at very much higher rates with settled sewage than with ordinary sewage.

"The removal of sludge by chemicals is not often employed as it is not of sufficient aid to filtration to justify its cost over plain subsidence. Straining and septic treatment have their fields of usefulness.

1605 The choice of these methods is a matter of profound judgment in any particular case, since the method employed may materially affect the degree of aerobic action in the filter, upon which purification of the great bulk of the sewage depends. The facts relating to the changes bacterial and otherwise which take place in these preliminary methods are all important as relating to and affecting the
1606 subsequent development of aerobic and anaerobic bacteria.

. . . . . , . .

Sand filters are commonly used where natural deposits or suitable sand or gravel are available. They are bacterial filters in which the aerobic action is largely carried on near the surface where the air comes most in contact with the sewage. Con-
1607 tact filters by which anaerobic and aerobic bacteria may be developed, are commonly used where there is no available sand and consequently the beds have to be artificially built."

A. Yes.

Recess.

XQ. 180. Returning now to the list of "septic tanks" or "septic action" references of the prior
1608 art given in your answer to XQ. 135, in which of them is the part that you compare with a septic tank, in fact a contact or cultivation filter?

A. Three out of the twenty-seven references, two being Scott-Moncrieff's process and the third Dibdin's Sutton contact filter tanks. With respect to Scott-Moncrieff's tanks, mentioned in the
1609 extract from British Press Publications, and also described in U. S. patent 530,622, Dec. 11, 1894, there is a chamber, that is, a septic tank, and not in fact a contact filter or cultivation bed, although above this chamber there is a tank used as a septic tank, but containing bedding material which acts like a screen or strainer and comprises what

is designated by Mr. Moncrieff as "the cultivation bed."

XQ. 181. Do the following excerpts from Professor Folwell's book of 1905, entitled "Sewage" (being the same book that I have quoted from before), refer to the systems of Dibdin and Scott-Moncrieff which you have cited (commenc- 1611
ing on page 401):

"Chemical precipitation has been adopted in many plants as a preliminary to filtration or land treatment; and many of those which have not adopted this retain the sewage for a short time in sedimentation tanks. The disposal of the sludge thus deposited is a most troublesome question, and various plans have been tried for avoid-
ing the formation of this. In the 'bacteria bed' 1612
of Dibdin very porous material is used—one-eighth to two inches diameter—which will drain out thoroughly and quickly and will permit the coarse suspended matter to enter the whole body of the filter and not the surface only. This material is placed in the tank or pit in which the sewage is retained for about two hours, permitting the bacteria to act during that time. The
organic matter being practically all liquefied and 1613
a large part of it nitrified.

(P. 420):

. . . .

"In the Scott-Moncrieff 'cultivation filter' the sewage passes upward through flints or other stones, leaving the solid matter behind, but carries with it all matter liquefied from sludge pre-
viously deposited. Here the aim is to combine 1614
both liquefaction and nitrification in the same filter, the liquefying anaerobes being segregated in the lower part, the nitrifying bacteria in the upper; although the former class of bacteria sometimes occupy the entire filter.

. . . .

The Moncrieff cultivation filter is essentially a continuous flow first-contact filter, in which the

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sewage enters from below instead of from above. A third fine grain filter is sometimes used, and Moncrieff has employed six or seven filters, one above the other, for purifying the effluent from his cultivation filter.''

A. The first quotation refers to Dibdin's filter that I had in mind; the second and third quo-
1616 tations, however—those relating to Scott-Moncrieff's filter—are evidently not references to the Scott-Moncrieff tank to which I have referred, but to a later patent and later tank than the ones I have hereinbefore spoken of and described.

XQ. 182. Is it true that in the Scott-Moncrieff system, cited by you in answer 135, the sewage
1617 passes up through the ''cultivation filter,'' instead of down, as in the case of Dibdin? A. Yes.

XQ. 183. Is the Dibdin system cited by you in answer 135 the same that you referred to in your direct testimony as follows (Ans. 21)?;

''As was expected, the Sutton 'contact Filter' overshot the mark, accumulated organic matter and had to be subsequently overhauled, but it did
1618 draw attention to possibilities of this form of filter hitherto unattempted in practice. Consequently it comprised one of the progressive steps in the bacterial treatment of sewage.''

A. Yes.

XQ. 184. Does the Scott-Moncrieff U. S. patent 530,622, to which you have referred, refer by ''conduit B'' in the following paragraph
1619 to what you have referred in answer 180 to as ''a chamber that is a septic tank?''

''By making the concentrating conduit B of less capacity or contracted as compared with the filter bed of larger area above it, and further by arranging the inlet of the crude material to said conduit at the extreme bottom thereof a result is obtained which is vital to the successful cultivation of the micro-organisms, as by this the crude material in the contracted conduit or chamber is kept constantly on the move, passing forward and upward without any place of permanent deposit, thus preventing the accumulation of stale, organic and foecal matter, which would destroy or retard the action of the micro-organisms."

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A. Yes, but I would like to call attention to a further description in said patent of the action that takes place in this "conduit B," which supports what I said in my answer to XQ. 180. The claim of the said patent is as follows:

"The herein described method of purifying sewage, which consists in passing the sewage, without previous removal of the solid portions, 1622 under a suitable head, first through a concentrating chamber with concentrated outlet openings in which the solid portions are retained until so far decomposed by the action of the micro-organisms that they can pass through the outlet openings, while the life products of the micro-organism are allowed to pass out with the liquid and finer solid particles without delay, and then upward through a filter bed of suitable depth and of 1623 greater superficial area than said concentrating chamber, whereby the decomposition of the solid matters is substantially completed, substantially as described."

XQ. 185. What are the outlet openings lettered in the Scott-Moncrieff drawing which you understand to be referred to in your last quotation, and where are they located relatively to the 1624 filter bed? A. These openings are marked C on the drawings, and they comprise a series of openings in the top of the said chamber B, and at the same time form the bottom and support for the cultivating filter.

XQ. 186. Do you know of any instance where

1625 F. HERBERT SNOW.

a system like that shown and described in the Scott-Moncrieff patent has ever gone into use in this country? A. Substantially like it, yes.

XQ. 187. Where? A. The tank hereinbefore cited by me as used in Medfield, Mass. I refer to the tank described in the 19th Annual Report of
1626 the Massachusetts State Board of Health Report for 1887, in which there is a strainer consisting of excelsior placed in the last compartment of the tank and in the upper portion thereof up through which the sewage has to pass to flow out of the tank. The details of arrangement are not the same as in the Scott-Moncrieff patent, but in
1627 practical operation the same results are secured; that is, the lower compartment corresponding to conduit B of said patent would retain heavy or the larger suspended matters where they would decompose and the more smaller particles would pass up with the liquid through the filter and be further decomposed therein.

XQ. 188. Are the following excerpts from your
1628 testimony in the Pawtucket case in regard to the Glover to whom you have referred in your direct testimony herein (pp. 335, 337)?

"Mr. Glover had a cesspool in the back yard of his residence in Brockton in 1882 when I went there. It was built of loose stones, so that the liquid would percolate into the adjacent ground, which was gravelly. Into this cesspool the sew-
1629 age of the house was first discharged. There was a second cesspool of the same kind and connected with the first one, so that the liquid would overflow from the first cesspool into the second one. Both cesspools were ventilated by means of the pipe attached to the side of the house and extending to the top. When I saw the cesspools in 1882 they were giving no trouble with respect to odors and did not have to be cleaned out Mr. Glover

attributed this fact to the ventilation which supplied fresh air to the cesspool, and, in some way he did not understand, operated to prevent the accumulation of solids.

"Upon this discovery which he claimed he made, that air would accomplish changes in the cesspool and render it unnecessary to clean them out, he took out this first patent No. 258,744. He
told me that he endeavored to cover this idea in 1631
his patent. He did not think filters were necessary at that time. He built a duplication of his two cesspools at the poor farm in 1882. They were made water-tight and he experimented with them and the results were disappointing in one rspect, that is, he did not get the same effect as in his old cesspool. The tanks accumulated sludge. I distinctly remember that this fact made
him more enthusiastic than ever about the value 1632
of his patent for separating out solids in sewage, he claiming that there was a fortune in the sale of these solids for fertilizing.

"In 1887, when Mr. Glover offered his plan to the City of Brockton, he had modified his ideas. He then included in his plan, first, a settling basin to be used without chemicals for the separation of the solids from the
liquid; second, a wall of gravel at one end of 1633
the settling basin through which the sewage was to filter; third, a series of arches of soft brick through which the sewage was intended to filter; there being four divisions each including this entire arrangement, to allow for cleaning, etc., all covered with a building having a central chimney for removing foul odors.

"After the Brockton disposal works were con-
structed--the same being started in operation in 1634
the fall of 1894—Mr. Glover claimed that that system was his. He watched its operation with great interest and had many conversations with me about it. I remember that he claimed that the process whereby the sludge naturally dried up on the surface of the Brockton filters was part of his invention. He tried to interest people in Brockton and elsewhere in the formation of a company

1635 for the construction of disposal works under his patent and he brought a good many individuals to Brockton to see the system in operation there and he told many of them, if not all, that the system was his system.

"During all these years I never heard Mr. Glover say one word about any bacteria except those whose
1636 activities were promoted in the presence of air. Putrefaction he thought would occur in any sewage and his invention was one calculated in his mind to obviate any nuisance by removing the solids and composting them for fertilizers and removing the odors necessarily accompanying this process of separation. His prominent idea was that these things could best be accomplished in his ventilated covered apparatus."

1637 A. Yes.

XQ. 189. Do you understand that the Glover cess-pool referred to in the first paragraph of the above quotation is the same that you have shown in your "sketch of Glover's Cess-pool, drawn by F. Herbert Snow?" A. Yes.

XQ. 190. In answer 67, referring to the septic tanks built by you since learning of the Cameron
1638 system, you have stated that they comprised "non-disturbing inlets." What, in your opinion, distinguishes a non-disturbing inlet from a disturbing inlet? A. I can answer that question much better if given a specific instance, rather than to make a general statement that will apply to all cases. The
1639 answer, if confined to the tanks to which I referred in XQ 67, is as follows: Instead of being below the surface of the water, when non-disturbing the inlet would be above it, if disturbing. If not confined to these tanks, my answer is, a largely increased sectional area into the sewage pool, when non-disturbing, instead of a small and non-increased sectional area of inlet into the sewage pool, when disturbing;

 1640

the idea being, that in a large pool formed by a wide
and deep excavation in a small ditch, into which
pool, the inlet and outlet were respectively increas-
ed in area and decreased, there would be a non-dis-
turbance of the contents of the pool. Even were
the inlets and outlets not increased in area where
they entered and left the pool, there would still be 1641
a portion of the pool in the central portion thereof,
in which the contents would not be disturbed.

XQ. 191. I believe the only references which you
gave in answer 135, of "septic tank" or "septic
actions," in the prior art that I have not already
touched upon in the cross-examination, are the Eng-
lish patents to Chapman and to Sloper, and to 1642
Adeney, and German patent to Muller. Does either
of these four patents show any apparatus or contain
any drawing? A. No.

XQ. 192. In which of the four patents to Chap-
man, Sloper, Adeney and Muller, respectively, are
chemicals described as a part of the process? A.
In all of them, but the use is optional in Adeney
and Muller, as I understand these patents. 1643

XQ. 193. Please read from the Adeney patent
the portion thereof which you consider to be a des-
cription of a process without chemicals? A. I
hereinbefore fully described this patent, as I under-
stand it, in answer to Q. 26. It begins in the first
line of page 2 of said British patent: 1644

"(Fig. 3) The third method of treatment, consists of thoroughly aerating the effluent from the first filter tank by converting it into a fine spray by means of an air-current and then allowing the aerated effluent to flow into the 'subsidence and incubation chamber' for the purpose and object above described of developing and multiplying the micro-organisms in the sewage and refuse liquors and destroying the organic matter in them."

XQ. 194. And is the following paragraph of Adeney a continuation of the above as to the same non-chemical process?

"The effluent from the 'subsidence and incubation tank,' when the third of the above methods of treatment is adopted, in non-putrefactive, when the liquid is maintained at a suitable temperature dur-
1646 ing all seasons, as we propose to do."

A. Yes.

XQ. 195. In view of the statement in the two paragraphs above quoted from Adeney, that the sewage is thoroughly aerated by means of an air current before flowing into the subsidence and incubation chamber, and that the effluent therefrom is
1647 non-putrefactive; are not these things inconsistent with there being a septic action or anaerobic action in said chamber, but consistent with there being an aerobic action therein? A. No; not when taken with other statements in the patent, or without these other statements. The said patent states:

"The liquors may be filtered and aerated at any of the stages of the process, but this is not neces-
1648 sary."

XQ. 196. The quotations of your last answer is taken from the final specifications of Adeney, whereas your previous quotations was taken from the preliminary specification. In the final specification do you find any process described not employing chemicals? A. No.

1649 XQ. 197. Then it appears, does it not, that the "third method of treatment" of the preliminary specification which you have pointed out as the non-chemical process, was dropped, or omitted from the final specification? A. The three methods mentioned in the preliminary specification are not so mentioned in the final specification.

XQ. 198. Now, confining yourself to the only
specification, namely, the preliminary specification,
in which a non-chemical method is mentioned, I un-
derstand it to be what is therein referred to as the
"third method of treatment" and that this third
method of treatment is throughout described as fol-
lows: 1651

"The sewage or refuse liquor is allowed to flow
into a subsidence tank in which the heavier parti-
cles in suspension in the sewage or refuse liquor
may be deposited, the effluent from the subsidence
tank is allowed to flow into a second tank furnished
with horizontal filters and herein named the first
filter tank, by which the lighter particles in sus-
pension in the sewage or refuse liquor are sepa-
rated. The said horizontal filters are composed of 1652
sand, quartz, coke, limestone, burnt clay, or any
other matter suitable for the purposes of the filter.
The effluent from the first tank may be treated in
any one of three ways as follows:

"(3) The third method of treatment consists of
thoroughly aerating the effluent from the first filter
tank by converting it into a fine spray by means of
an air current and then allowing the aerated efflu-
ent to flow into the 'subsidence and incubation 1653
chamber' for the purpose and object above de-
scribed of developing and multiplying the micro-
organisms in the sewage and refuse liquors and
destroying the organic matter in them.

. . . .

"The effluent from the 'subsidence and incuba-
tion tank' when the third of the above methods of
treatment is adopted, is non-putrefactive, when 1654
the liquid is maintained at a suitable temperature
during all seasons, as we propose to do.

"The effluents from the 'subsidence and incuba-
tion tank' flows into the last tank of the system
which is also provided, similarly to the first filter
tank, with horizontal filters, the material of the
filters being sand, quartz, coke, limestone, burnt

clay, or any other material suitable for the purposes of the filter.

"The effluent from the last tank may be discharged into a river or water-course without any dangers of poisoning the water or in any way creating a nuisance, or rendering offensive such river or water-course."

1656 Is that correct? A. Yes.

XQ. 199. And do you mean to say that the action in the so-called "subsidence and incubation" chamber or tank would necessarily be a septic action in accordance with the above description notwithstanding the statement in said description that the effluent therefrom is "non-putrefactive" and that
1657 the sewage entering the same is thoroughly aerated "by converting it into a fine spray by means of an air current?" A. Yes. It does not appear how anaerobic fermentation could be prevented. The object of the tank is to promote the development and multiplication of the micro-organisms in the sewage for the purpose of destroying the organic matter in the sewage. In the said specification, it is
1658 stated:

"The germs of such micro-organisms are generally contained in the liquor, but they may be specially bred and added to it."

Anaerobic organisms can be bred and added in a liquid to sewage, but it does not anywhere appear that aerobic organisms can be bred and added in
1659 liquid, or in any other way to sewage. Furthermore, the confining of sewage in liquid bulk in a tank whose temperature is to be maintained at a high even degree of itself implies putrefactive fermentation. There is nothing inconsistent in the statement in the said patent with my view of the action in said third method in the subsidence and

 1660

incubation tank, that the effluent therefrom is not putrefactive. This is quite likely to be the case with effluents from septic tanks.

XQ. 200. In this Adeney process, upon what, in the preliminary specification do you base your statement that the temperature was to be maintained at a high degree, where no chemicals were used? 1661
A. I had in mind the claim of the patent which states the degree of temperature, but that claim also involves the use of chemicals, and is not in the preliminary specification. Confining myself to the preliminary specification, the fact that it is the purpose of the process to maintain a suitable temperature during all seasons, involves, in my judgment, 1662
artificial means to achieve this object. Micro-organisms are known to diminish their activities in a lower temperature and increase them in a higher temperature, and I conclude, therefore, that it is the intent of the process to maintain such a higher temperature as will promote the activities to the most suitable degree of these organisms which de- 1663
stroy the organic matter in sewage when it is contained within the body of the liquid.

XQ. 201. The Adeney patent does not say whether the "suitable temperature" is to be maintained by heating or by cooling, does it? A. No.

XQ. 202. Nor does it say how long the sewage is to remain in the so-called "subsidence and incuba- 1664
tion" chamber or tank, does it? A. My last answer, and this one also, is confined to what is stated in the preliminary specification and not to what is stated in the final specification. My answer is, No.

XQ. 203. What effect would the preliminary passage of the sewage through the "horizontal filters" in the first filter tank have upon the sludge,

1665
so far as entering the subsidence and incubatión
chamber or tank is concerned? A. It would fur-
nish a catch-pit for grit and intercept floating mat-
ters like paper, orange peels, &c., and depending up-
on its construction wholly, admit other suspended
matters to passage through it.

1666 XQ. 204. What do you understand to have been
the purpose of thoroughly aerating the sewage by
converting it into a fine spray by means of an air
current just before allowing it to flow into Adeney's
subsidence and incubation tank? A. The purifica-
tion of the sewage to as great a degree as this pro-
cess would effect this purification, it having been a
1667 common belief for many years, that the greater the
aeration the greater the purification of sewage.

. XQ. 205. Do you think that that would be con-
ducive to the production of a septic action in the
subsidence and incubation chamber? A. Yes, most
decidedly.

XQ. 206. Why? A. Because it would freshen
the sewage, and it has hereinbefore appeared that
1668 fresh sewage is better adapted to septic action than
stale sewage.

XQ. 207. Have you ever employed such a pre-
liminary thorough aerating of the sewage by means
of converting it into a fine spray by means of an
air current, as a preliminary to permitting it to
1669 enter any of the septic tanks in the ten plants that
you have built since learning of the Cameron sys-
tem? A. No.

XQ. 208. Will you now please quote from each
of the claims here in issue of the Cameron patent in
suit which you have stated to be not infringed by
the Saratoga plant, the words that are not infring-
ed in your opinion, the claims in issue being 1 to 8

 1670

inclusive, 11 and 12, 20, 21 and 22? A. In Claim 7, the words "said outlet comprising a conduit, having a longitudinal slot open across the greater part of the width of the tank."

In Claim 8, the following words, "An outlet consisting of a pipe extending across the greater part of the width of the tank and disposed above the bot- 1671
tom and below the normal water level thereof, said pipe having an opening in its wall throughout its length for admitting the effluent."

In Claim 6, the words "settling tank," for this element is entirely lacking in the Saratoga plant, but is an essential element of Claim 6 which provides for the combination of a sewer, a settling 1672
tank connected therewith and a septic tank connected with the settling tank.

XQ. 209. In answer 9 you stated that in the Saratoga plant, the grit chamber is dispensed with; is the sewage at Saratoga pumped from the sewer outlet up to the level of the tank? A. Yes.

XQ. 210. Do you mean to say that if a solid
substance like a spoon, for example, should come 1673
along with the sewage, it would be pumped up to the tank? A. I mean to say this; that any substance that would flow along with the sewage from the sewer system to the pumps would be passed through the pumps and into the septic tank. A spoon would not be likely to pass through the sew-
ers to the pumps. There are screens at the pump 1674
well such as are always common in all pumping stations, to prevent a clogging of the pumps, but these are not intended and would not prevent mineral matters, such as silt, &c., from reaching the tanks. It is the intention to take everything that will pass the pumps into the septic tanks.

XQ. 211. You state that a spoon would not be likely to pass through the sewers to the pumps, but my question is, suppose it did, would it be pumped up to the tank? A. Yes, if it were possible for it to reach the pump well, since the velocity through the pumps and the force main is greater than in the
1676 sewer discharging into the pump well, the spoon could pass more readily from the pumps to the septic tanks and there is no catch pit or any means provided for the intentional interception of anything passing through the force-main.

XQ. 212. I believe you have stated that the outlet from the Saratoga septic tank consists of 96 holes extending in two rows across the end of the
1677 tank. What, if any relationship in designing the tank have you observed between the size or capacity of these holes and the flow of sewage through the tank?

Adjourned to Wednesday, June 28, 1905, 10:30 A. M.

1678 New York, June 28th, 1905, 10:30 A. M.

Met pursuant to adjournment.

Present, counsel as before.

Cross Examination of Mr. Snow Continued:

(Witness answers XQ. 212).

A. The total area of these holes is sufficient to conduct away from the tank a volume of effluent
1679 equal to any flow of sewage into the tank.

XQ. 213. If there are any tanks in the prior art mentioned in your testimony which are "settling tanks," in the sense in which that term is used in contradistinction to "septic tank" in the quotations made from your Pawtucket testimony in XQ. 134 of your present deposition, please state which

of such "settling tanks" you consider to be the
nearest approximation to claims 5, 6, 7, 8, 11, 12
and 21 repectively? A. In the answer I am about
to make, the tanks herein referred to were used as
"settling tanks" in the sense specified in the ques-
tion; but they may also have been used—or some of
them—as "septic tanks," I having no means of 1681
knowing whether in fact they were used as a "septic
tank" or not.

With respect to Claim 5, which is the broad ap-
paratus claim of the patent for a tank with an out-
let submerged and open across the greater part of
the width thereof and connected with an aerator, I
will mention as the nearest approximation, British
patent, No. 3562 of 1868 to Thomas Smith and 1682
another; British patent, No. 2760, of 1871, to James
B. Pow, and United States patent, No. 505,166,
September 19, 1893, to Oluf E. Meyer.

With respect to Claim 6, which comprises the com-
bination of a sewer, a settling tank or grit chamber,
and a septic tank, I will refer as near approxima-
tions to British patent, No. 232, of 1860, to Thomas 1683
Walker, and British patent, No. 2329, of 1864, to
Thomas Walker and another; and British patent,
No. 742, of 1872, to John Baily Denton and another,
and to United States patent, No. 108,664, of October
25, 1870, to George W. Wigner; and to United
States patent, No. 138,250, dated April 29, 1873, to
Fritz Hille, and to United States patent, No. 280,- 1684
545, dated July 3, 1883, to Silas Wilcox; also to
British patent, No. 3562, of 1868, to Thomas Smith
and another. Placing these in the order of prefer-
ence, they are as follows:

Smith, second Walker patent, Wigner, Wilcox,
first Walker patent, Hille and Denton.

Also the Burnham sewage works, and those at Frankfort, Germany.

Regarding Claims 7 and 8; Claim 7, providing for an outlet conduit with a slot its entire length, and Claim 8, providing for the outlet to be a pipe, I will name as the nearest approximation, and in-
1686 cluding them in a group:

First, British patent, No. 2329, of 1864, to Walker and another.

British patent, No. 3562, of 1868, to Smith and another.

British patent, No. 2760, of 1871, to Pow.

U. S. Patent, No. 505,166, of 1893, to Meyer.

1687 U. S. Patent, No. 580,793, of 1897, to Mitchell.

Second, British patent, No. 7174, of 1887, to Gurtler.

Third, The tanks at the Worcester State Hospital.

The Cheltenham tanks, and the proposed Austen tank.

With respect to Claims 11 and 12; Claim 11 be-
1688 ing the same as Claim 5, with a wide inlet added, and Claim 12 being the same as Claim 7, with the wide inlet added, I will specify as nearest approximations:

British patent, No. 2329, of 1864, to Walker and another.

1689 British patent, No. 3562, of 1868, to Smith and another.

U. S. patent, No. 505,166, of 1893, to Meyer.

British patent, No. 364, of 1870, to Wigner.

U. S. patent, No. 184,099, of 1876, to Moore.

Taken in order of precedence, and:

The Clifton Union Works and The Austen proposed tank.

And respecting Claim 21, which is the same as
Claim 2, substantially, with further mention of or
use of the word " scum," the approximations are the
same as I mentioned in my answer to Q. 33, because
I have nowhere in my direct examination, so far as
I now recollect, made any distinction in the kind
of scum found on a settling tank, from that found 1691
on a septic tank. I can not, therefore, do so now,
and answer the question as put.

XQ. 214. Is the following an excerpt from the report of your interview appearing in the Baltimore News of May 22, 1905, and does it report what you said with substantial correctness:

"As a rather extraordinary feature of the pres- 1692
ent situation, Mr. Snow said that practically every
successful system of sewage disposal is claimed by
someone as a patented right. He declared that per-
sonally he does not believe these claims are well-
founded, but that there are several cases now pend-
ing in the courts which will decide the claims
finally. Baltimore should, he said, be prepared in
the event of its deciding to adopt some method of
disposal to have a claim made for royalty for use 1693
under patents, but he added that Baltimore should
not worry very much over such a claim, but should
do as other American cities have done and refuse
to pay any royalty."

A. This is a correct quotation from the Balti-
more News, but it does not accurately or substan-
tially represent my views on the subject matter
therein contained. 1694

XQ. 215. Do you now verify the correctness of the excerpts quoted in the cross-questions? A. I have not yet verified them, but I have no doubt they are correct and they may be so considered unless I later state to the contrary.

Re-direct Examination by Mr. Banning:

R-d-Q. 216. What patent was sued on the Pawtucket case, referred to in your cross-examination? A. The title of the case was "American Sewage Disposal Company of Boston v. City of Pawtucket," U. S. Circuit Court, District of Rhode Island, on Glover patent, No. 559,522, dated May 5, 1896.

1696 R-d-Q. 217. In the course of your cross-examination, complainant's counsel has made frequent and extended quotations from your testimony in that Pawtucket case. In view of this, I now ask you to make any other, or further quotations from such testimony that you consider necessary, particularly to afford a proper understanding of the parts quot-
1697 ed in your cross-examination as above—also making any explanatory statements or suggestions in connection therewith that you consider necessary?

A. On page 442 I said:

"The object of the septic tank cannot be secured in practice without the presence of large quantities of water, in which those matters in a solid form which are capable of being dissolved are dissolved
1698 and carried off in the bulk of the liquid. If there is not a sufficient quantity of water, these dissolving actions would not be carried on to advantage. In my opinion, the water in a septic tank should be at least seven feet deep to secure good results."

This statement defines the difference between an ordinary cesspool used in the sense of the old meaning of the word "cess-pool," and, the use of the
1699 word cess-pool as applied to the modern receptacle of that name; for instance, such as cess-pools of the Mouras type and of Waring and Phillbrick, and others herein mentioned in my testimony which I have cited as comprising septic tanks. In that statement, when I said "seven feet deep," I was referring particularly to tanks of large size, and I am

of the same opinion now. Further, this depth is the one which I think is necessary for an ordinary settling tank of large size, that is, I should build a settling tank of at least seven feet in depth.

On page 434, is the following:

R-x-Q. 245. You say that before Mr. Cameron's time the putrefactive process on a large scale was 1701
frowned upon as a nuisance and not because unknown, in your answer toR-d-Q. 224. I do not, however, understand by that that you mean to deny that the extent to which the solids might be dissolved and putrefaction avail of in sewage disposal, was uworked out and unrecognized by sanitary enginers, or others, until after that date. Am I correct in that? A. You are correct."

I wish to reiterate that statement now. The ex- 1702
tent to which solids might be dissolved and putrefaction availed of in sewage disposal, had been worked out and recognized and put to practical use in America, in France, and in Italy. In America by myself, and Waring, and Phillbrick, and by others hereinbefore mentioned by me. In France by those using the Mouras process, hereinbefore mentioned 1703
by me. In Italy, by Pagliani, as hereinbefore fully described. So, the process was recognized by sanitary engineers of the highest authority, prior to Cameron's time.

On page 428 is the following:

"R-d-Q. 224. In your direct examination, and again in answer to XQ. 174, you have said that you 1704
believe that Phillbrick's tank was intended to act as a septic tank combined with means of purification by oxidation, but in answer to XQ. 172 you have said that you did not think that the origin or adoption of the use of structures designed for putrefaction in the treatment of sewage could be attributed to Mr. Phillbrick's article, especially with reference to municipal sewage disposal. The two

1705 statements appear to be more or less inconsistent. Please explain your meaning? A. The two statemets are consistent with the facts in the case to which I have already testified, namely, that while the dissolving actions which took place in the old time cesspool were recognized and made use of by Mr. Phillbrick, and even before his time, the application of his principle to a municipal plant was
1706 first made by Mr. Cameron at Exeter in England. Before this latter time the putrefactive process on a large scale was frowned upon by sanitary experts because of the nuisance likely to be engendered by its adoption, but not because the process was unknown, and since the Cameron septic tank the attention of investigators in sewage disposal has been directed to this particular phase of the sewage disposal problem. Therefore, I stated that
1707 I did not believe that the adoption of structures designed to treat sewage of municipalities by the putrefactive process could be attributed to Mr. Phillbrick's article."

As making my meaning clear, I wish to add at this time that Mr. Cameron's application at Exeter, England, of the Mouras process drew attention of engineers, at the time when in the devel-
1708 opment of the art their attention was easily directed to the process, to the fact that it could be applied to a municipality without necessarily producing a nuisance.

On page 427 I said:

"Some septic tanks are operated to effect little more, if any, than staleing action, and the effluent
1709 from such tanks does not practically differ, so far as the rate at which it may be applied successfully to a sand filter, from the effluent from a settling tank of considerable size in which the separation of the solids from the liquids by plain subsidence is intended. In a settling tank holding a day's supply of sewage, the staleing action which is unavoidable will produce an effluent from that tank which, in my opinion, may be applied in as large

quantities to a given area of sand filter as the effluent from the average septic tank."

In other words, the main advantage of an ordinary septic tank over a settling tank is not in the higher rates which the effluent may be applied to a sand filter under the conditions above mentioned. 1711

On page 424 I said:

"Its construction and method of operation corresponds with the construction and operation of tanks purposely designed to secure septic action, and since the solids intercepted in this tank are retained until the tanks fill up or there is a very considerable accumulation of deposits in them, there is, in fact, some degree of putrefaction and
therefore my answer is in the affimative. I do not 1712
wish to be understood as meaning that the Marlborough plans comprise the intentional use of septic action to a degree which if abandoned in the operation of the plant would render the said plant inefficient or inoperative."

I wish to emphasize the fact that the Saratoga plant does not comprise the intentional use of
septic action to a degree which, if abandoned in 1713
the operation of the plant, would render the said plant inefficient or inoperative. The plant would be run just the same as it is operated now except that the solids in the tank would be emptied out frequently onto the filters especially prepared for their reception. It seems to be the intent of the
patent in suit to avoid the formation of sludge. 1714
Line 35 on page 2:

"By this invention crude sewage can be treated for long periods without practically any sludge at all forming in the tank."

In Cameron's first British patent it is stated:

"The solid portion of crude sewage is entirely thrown into solution."

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This, as I understand the subject, is problematical with any particular sewage. Every plant is, of necessity, an experimental one and all that can be hoped for is the utilization of the dissolving action to the extent that it is practicable to utilize them in that particular instance. The de-
1716 fendants' plant contains no elements or provisions not used in the prior art in connection with settling tanks, and the defendants' tanks can be used as settling tanks only without detriment to the operation of the plant as a whole. However, the use of the dissolving actions is intended therein, as the plant is now operated and has
1717 been operated since being first started.

On page 424 I also stated:

"It is my opinion that the designers of the apparatus mentioned in the question knew of the liquefying, dissolving actions which took place in the old time cesspools and that they had this idea in mind in the said designs, and intended to take advantage of the said action in their respective apparatus, but not to the degree which has since been found pos-
1718 sible after the Cameron experiments were made known."

I wish to add to this statement that as I have hereinbefore shown, Mr. Cameron had a limited knowledge of septic action at the time he was granted his British patents. Since that time the degree to which liquefaction could be carried out
1719 in sewage of different kinds has been determined by many experimentors, among which I have hereinbefore mentioned the Massachusetts experiments. Prior to that time there were the experiments of Mouras and Muller, the former being widely circulated in publications in France, England and America.

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On page 419 is the following:

"XQ. 177. Referring to the statement by you, R-319, 'one of the first applications of the Philbrick design for the intentional utilization of the putrefactive process in so far as it mascerated and finely divided the solid matters was at the Lawrenceville School.' What is you authority for saying that there was any 'intentional utilization' of said process at Lawrenceville? A. My authority 1721 for that statement was the declaration by the engineer who designed and constructed the plant, Mr. J. J. R. Croes, made by this gentleman on November 4, 1903, in an address by him before the State Sanitary Association of New Jersey, at which time and place I was present and listened to his remarks, and later at the same meeting conversed with him further about it."

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On page 400 I said:

"I do not deny that Mr. Glover contemplated the same sort of action in the settling tanks of the plan he offered to the city of Brockton, in 1887, as he claimed took place and destroyed the solids in his cesspool. In fact, I remember that he laid considerable stress on the settling actions in the basins and the value of the deposits for fertilizers, and that he also had a good deal to say about the filtering of 1723 the sewage through the gravel walls and arches of soft bricks. The bacterial action was not emphasized at this time by Mr. Glover. The whole apparatus is offered as a mechanical device and not as a natural, living, organic process."

I mention this at this time because I have hereinbefore referred to Glover's first patent which was not the one in suit in the Pawtucket 1724 case, as an instance of anticipation of the septic process. That patent and the plan referred to in the above quotation were not the same.

On page 397 I said:

"The beginning of my confidence in the use of putrefaction as a method of treating sewage on a large scale was after Mr. Cameron had exploited

1725 his Exeter septic tank experiments, and as near as I can recall about 1898. By this answer, I do not wish to be understood as stating that I have no recognition of the dissolving actions which occurred in the old time cesspools; because I knew of these actions and also of their application to small household plants. The reason that the process was not applied on a larger scale was that the
1726 opposition to the introduction of sewage disposal plants for municipalities was always from the standpoint that their installation would create a nuisance, and to allay this opposition, as far as possible, projected plans intentionally eliminating all features which would tend to promote putrefaction, but included and made prominent those features and facilities which embody the treatment of the sewage while in as fresh a condition as pos-
1727 sible. It was because of the bugaboo of the nuisance more than to any other cause that attention was not paid to the carrying of the putrefactive process to a stage greater than it had already been used prior to Mr. Cameron's septic tank. When Mr. Cameron demonstrated the practicability of the use of this process on a large scale, an impetus was given to investigation of the subject, and it was about this time that I began to consider the
1728 use of putrefaction on a practical scale."

I reiterate the statement, but by it I do not wish to relegate Mouras' published experiments in British, American and French publications, and the application of the process in practice in France and Italy wherein the solids were said to be all liquefied, to the background. Nor to War-
1729 ing's published statement that the decomposition in the settling tank of his system was so great that in some cases the said tank did not have to be cleaned out, and his system had been perfected so that he would not hesitate to apply it to villages and towns—all of which has been very fully hereinbefore mentioned and described. But

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it was about the time Cameron riveted everybody's attention to the process as he had applied it in Exeter that I began to pay marked attention to it.

On page 391 I was quoted as saying:

"'The septic tank is a modern method, in the sense that it was not recognized as a practical mode 1731
of treating a large volume of sewage until about six years ago. It is not a modern method in the sense that the action peculiar to sewage confined in receptacles has been known and observed for many years.'"

In respect to this quotation I said:

"It should be understood that this discussion of mine was given off-hand without preparation, and that any mention of dates or years was to be under- 1732
stood as approximate only. I had in mind, in using the words 'six years ago,' reference to Mr. Cameron's recognition of this mode of treating sewage on a practical scale, which was in the year 1895; and I also had in mind ideas of my own upon the subject which were crystallizing into form from observations made and being made at Brockton."

R-d-Q. 218. Referring to the quotation from your Pawtucket testimony contained in XQ. 47 1733
herein, did you in such quotation refer to the "septic process" or simply to the term "septic?" A. I referred only to the use of the word "septic" and not by any means to the process which had been known before Mr Cameron's time.

R-d-Q. 219. To whom was it known? A. It was known to me, to the Massachusetts State 1734
Board of Health, to Waring, Phillbrick, Glover, Union and to those who had understandingly read various American publications describing the solvent action in sewage, among which publications I mention the Engineering News, the Sanitary Record, Waring's books and the various reports

1735 of the Massachusetts State Board of Health—all of which have been hereinbefore mentioned. It was also known to Scott-Moncrieff and described in his U. S. patent No. 530,622 of 1894. Also to Mouras, Muller, Pagliani, Adeney, and to those who read the various British, French and Ger-
1736 man publications hereinbefore described, in which the processes of these inventors were exploited.

R-d-Q. 220. How did it come about, then, that Mr. Cameron received so much credit in reference to the matter, particularly as shown in the publications referred to in your cross-examination? A. By adroit business methods and advertising
1737 at the time when people were looking away from the antiseptic processes of treating sewage which had hitherto prevailed largely in England towards the opposite processes, as exploited by Moncrieff, Adeney and Dibdin in England, and by the Massachusetts State Board of Health in America.

1738 R-d-Q. 221. Briefly, what do you understand the Exeter septic tank experiments were and what did they demonstrate? A. There were three experiments, each with a covered tank. The first tank was small, built on the Mouras type and without filtration, based upon which experiment I understand Cameron and Cummin obtained
1739 their first British patent, No. 21,142 of 1895. The second tank was about twice the size of the first one. Filters were attached. The third experiment was the most important one, that one usually referred to publicly, and upon which, as I understand it, British patent No. 23,042 of 1896 was granted to Cameron, Cummin & Martin, the specification of this patent being worded consid-

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erably different than the specification of the patent granted to the said Cameron, Cummin and Martin by the U. S. Patent Offices, said U. S. patent being the one in suit.

R-d-Q. 222. When did Mr. Cameron first publicly state what he knew about his septic tank action? A. In his testimony before the Royal 1741
Commission on Sewage Disposal hereinbefore mentioned by me in my answer to Q. 26.

R-d-Q. 223. Was his knowledge of the subject any greater than the knowledge of others at that time? A. No. The chemists and bacteriologists who had been called into examine and report on what was being accomplished in the Exeter tank, 1742
and made a report in connection with an examination by the local government board of the Exeter plant knew more than Cameron did about what was taking place in the tank, and he acquired much of his knowledge thereof through these sources.

R-d-Q. 224. Did others also experiment with 1743
the septic tank process as well as Cameron, and who? A. Yes; besides the Massachusetts experiments there were those at Leeds, and also at Manchester, in England; Muller and Mouras' experiments were the first, however. I should also mention Scott-Moncrieff and Adeney's experiments, and those of Glover, which were conducted prior to Cameron. 1744

R-d-Q. 225. Did these experimentors call the process "septic action?" A. Those prior to Cameron, that is, Muller, Mouras, Glover, Scott-Moncrieff, and Adeney, did not call it septic action. And the Massachusetts experimentors did not call it septic action until Cameron so named

1745

it. Afterwards, the Massachusetts experiments were called "septic tank experiments," and so were those at Leeds and Manchester.

R-d-Q. 226. Referring to your answer to XQ.
80, as a matter of fact did the Massachusetts
State Board of Health lead or not? A. The
1746 Board were far ahead of the most advanced
knowledge in the art as relating to the nitrifica-
tion of sewage, but as I have hereinbefore ex-
plained, Dibdin, Scott-Moncrieff, and Cameron
also took part in directing attention to specific
phases of the art which had been previously
known, but not wholly worked out.

1747 R-d-Q. 227. Was the work of the Massachusetts
State Board of Health especially directed toward
the points now in controversy, particularly to-
ward "septic action," or in what direction was
it pointed? A. I understand that the Massachu-
setts experiments were largely directed toward
the nitrification of sewage at first, and that their
energies were bent in that direction so exclusively
1748 during the first three years that, not unlike an
express train, nothing could turn it in the oppo-
site direction until it had first arrived at its desti-
nation. In convering the nitrification route, va-
rious things were observed, such as the initial
and preliminary changes in the breaking down
of the organic solids in sewage by mechanical,
1749 chemical and bacterial agencies, specified as both
aerobic and anaerobic. But these observed ac-
tions were not put to trial to ascertain the fullest
extent to which the septic action would be advan-
tageous until 1897. The Board did know about
the liquefaction process before, but this involved
putrefaction. In Massachusetts Municipal Sew-

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age Disposal Works the object sought was to get the sewage disposed of in as fresh a condition as possible. As I have previously stated, the question of a possible nuisance made it difficult to procure land for disposal purposes. I speak from experience at Brockton. In 1887 and 1891,
when we had to argue to get legislative sanction 1751
to the right to take land for filtration purposes, that the sewage would be in fresh condition when applied upon the filter, and therefore no nuisance from an odor would thereby be established. Again in 1898 I had the same difficulty at Clinton, Mass. It was in connection with this case that I talked with Mr. F. P. Stearns, formerly Chief Engineer
of the State Board of Health, about septic tanks 1752
for Clinton, but the possibility of objectionable odors therefrom precluded the adoption of this system there. At Brockton and at Clinton the filtration areas comprised about twenty acres each. The objection in the minds of the public was that these broad areas would become open
cesspools and be a menace to the neighborhood. 1753

R-d-Q. 228. Referring to XQs. 108 and 109, did Cameron's Exeter septic tank separate the solid from the liquid sewage? A. Yes.

R-d-Q. 229. Did it remove the solid as a solid from the sewage as distinguished from its removal by liquefaction? A. Yes.

R-d-Q. 230. Referring to XQ. 110, did Cam- 1754
eron's Exeter septic tank liquefy all the suspended organic matter in the sewage? A. No. Many of them passed out of the tank and were deposited on the surface of the filter or passed into the interstices thereof and therein accumulated, reducing the capacity of said filters. In his

testimony hereinbefore referred to by me he stated that it was in September, 1896, that he first observed that his tank would have to be cleaned out some time, but he did not know when. In this connection I will call attention to the specification of the first patent which stated that the
1756 solids would be entirely dissolved by the process.

R-d-Q. 231. In cross-question 113 there is a quotation from an article in the Engineering News by H. W. Clark, Chemist of the Massachusetts State Board of Health, referring to the "So-called septic tank system first in operation in Exeter, England," in which appear these words:

1757 "Anyone who had ever had any experience with or noted the changes taking place in an ordinary cesspool, must have had their attention drawn to this fact. We have not, however, ever considered in the past that these actions could be utilized as now proposed by the septic tank system."

What do you understand Mr. Clark to have meant by the last sentence of the language here quoted? A. Simply this: That the absolute dis-
1758 appearance of all the solids in sewage in liquid form by natural dissolving actions in a tank, had not been considered possible before Cameron made his remarkable claims to this effect. It was this remarkable claim with respect to the Exeter septic tank that secured for it the attention it received in England, and consequently in America.
1759 Had Mr. Cameron not conducted his experiments for the Exeter authorities, and had not the smaller experiments been adopted and put in practice on a large scale there, they would not, in my opinion, have become famous. Briefly, this is what he did: He put Mouras' process, pure and simple, to a test, and proved that it would work. He

then got the system applied locally at the time
when the world was looking for something of the
kind, and backed up by patents, judicious man-
agement, and fortuitous and extensive free adver-
tising, his system came heralded as a new process,
a wonderful discovery, and the beginning of a
new epoch in sewage disposal. 1761

R-d-Q. 232. Referring to XQ. 116, what do you
understand the language from Mr. Clark's article
therein quoted to mean? A. I understand it to
be, among other things, an explanation of why
the Massachusetts experimentors did not pay
more attention to the so-called "septic" action
before Cameron called it by that name. This 1762
statement seemed to be called for because the
idea was gaining credence among engineers that
the Massachusetts State Board of Health had
overlooked septic action and contact filtration,
which English experimentors were exploiting as
new discoveries. In this connection I will quote
from page 435 of Mr. Clark's Report to the said
Board of Health in said Board's Report for 1898: 1763

"But, as oxygen is not present, the action by
which the organic matter is still further changed
is a putrefying one, and the sewage becomes very
ill-smelling on account of the generation and escape
of hydrogen compounds of carbon, sulphur and
phosphorus. Nitrogen is also set free in this putre-
fying process. The result of all these changes is
to decrease the amount of carbonaceous and nitro- 1764
genous matter in the sewage. Sewage when in this
state is now known, since the results of certain
English experiments have been published, as
"septic sewage;" not a very appropriate term, but
one which we shall probably have to accept on
account of its general use at the present time."

R-d-Q. 233. Referring to XQ. 121, are the meth-
ods of sludge disposal described in the language

1765 therein quoted from Rafter & Baker's book all the methods that could have been mentioned in 1894; the date of said book? A. No.

R-d-Q. 234. What would you add? A. The Mouras, Adeney, Scott-Moncrieff processes, known at that time.

1766 R-d-Q. 235. Are these referred to in any way in Rafter & Baker's book? A. Yes; on page 204:

"(4). That the arrangements for removing the sludge be such as to insure its frequent removal, for if left in the tanks until putrefaction sets in the sludge is likely to rise to the surface, giving off foul odors."

1767 This shows that they, in common with many others, myself among the number, were aboard the non-putrefactive train of thought on the subject. We knew of the other route, but considered this one the safer.

R-d-Q. 236. What do you understand Col. Waring to mean by the sentence last quoted from his

1768 book in XQ. 122, namely:

"As a matter of fact, such preparatory treatment opened the field for invention and improvement that is well worth exploiting."

A. He referred to the method of removing or disposing of sludge by oxidizing processes prior to the liquid sewage being filtered. In 1894, the date of his book, the whole trend of thought and

1769 attention of those pursuing the development of the art of sewage disposal was directed towards the accelerated processes of oxidation. It was at this time that Col. Waring undertook his experiments at Newport on forcing air through strainers to oxidize the accumulated matter strained out through the sewage. He had previ-

 1770

ously, as I have hereinbefore stated and shown, worked out the putrefying process of dissolving sludge and found it practicable. But he preferred the oxidizing process as safer. His reasons were the same as I have stated in my answer to R-d-Q. 227.

R-d-Q. 237. In XQ. 123, quotations were made 1771
from Dr. Ridell's book; will you please state whether the following are excerpts from the same book (p. 162)?

"Pasteur proved that fermentation and putrefaction did not take place in the absence of living organisms, which he divided into aerobic, or thriving in the presence of oxygen, and anaerobic, or growing without it. Their life history and char- 1772
acter have since been elaborated by Koch and a number of other observers."

On page 164:

"The earliest modern initiation of the bacterial treatment of sewage appears, as Mr. Reechling has pointed out, to be due to Dr. Alexander Mueller, who came to the following conclusions; . . . . It would seem from this, that Dr. Mueller realized the importance of a preliminary 1773
change first taking place."

On page 165:

"About the same time the 'Mouras automatic scavenger, was inaugurated in France. According to the Cosmos Les Modes, December, 1881; January, 1882; 'This mysterious contrivance, which has been used for 20 years, consists of a closed vault with a water seal, which rapidly transforms all the excrementitious matter which it receives into 1774
a homogeneous fluid, only slightly turbid, and holding all the solid matters in suspension in the form of scarcely-visible filaments. The vaults itself emptying, and continuous in its working, and the escaping liquid, while it contains all the organic and inorganic elements of the faeces, is almost devoid of smell, and can be received into watering carts for horticultural purposes, or may pass away

1775 into the sewer for use in irrigation.' As to the
theory of the action, it is said, 'May not the unseen
agents be those vibrions or anaerobics which,
according to Pasteur, are destroyed by hydrogen,
and only manifest their activity in vessels from
which air is excluded." A later article of January,
1883, by the Abbe Moigno, gives formula for the
1776 dimensions of the tank, estimating its superficial
area as preferably 1-10 metre, or about 1 square
foot per person. The Exeter tank, I may remark
in passing, works out to about 0.6 square foot per
person."

Page 208:

"We next come to processes that rely for purification
on the natural action of bacteria without
extraneous aid. This idea had been indicated in the
1777 "Automatic Scavenger" of Mouras which we have
already described, and could also be gathered from
the Massachusetts investigations, but prior to the
latter, in 1890, Scott-Moncrieff made a number of
experiments with regard to the observed rapid putrefaction
of organic matter in sewers. If this
action, which was now known to be due to liquefied
bacteria, could be intensified and regularly conducted
within a small area, it promised to eliminate
the sludge difficulty.

1778 "It had long been known that in the slow filtration
of sewage, more particularly when the direction
was upwards, so that little or no mixing with
air occurs, very considerable changes in the organic
matter were brought about, entirely unconnected
with oxidation. Thus in Frankland's experiments,
as early as 1870, when a strong London sewage was
made to traverse, 'continuously upward so as to
1779 exclude aeration,' a layer of sand, the analysis of
sewage and effluent given is the most instructive
as the meaning of it was not understood at the
time. . . . .
That is to say, the anaerobic bacteria have acted in
the usual way:

. . . .

"Mr. Moncrieff began on a practical scale in 1891
by constructing at Ashted a bacterial tank into

 1780

which the crude sewage was admitted from below and gradually passed upwards over the surfaces of a bed of stone. He found that the liquefaction of the solids was so effective that the whole sludge of seven years from a household of ten persons was absorbed on nine square yards of land, causing no distinction in appearance between this soil and that surrounding. The space between the under-
grating of the tank had a capacity of less than five 1781
cubic feet, and would obviously have filled up in a short time but for the liquefying action that had taken place.

"In 1892 his process was examined by Dr. Houston and later by Dr. Sims Woodhead and myself. Dr. Houston's report of 1893 is practically the first literature on the purification of sewage as a whole bacteriologically, without deposition or chemicals
and with hydrolosis by micro-organisms of the 1782
grosser organic matter as a prelude to further treatment, a point which is not mentioned in the Massachusetts Report."

On page 242:

"It has been remarked that a really anaerobic treatment in the first stage, like Cameron's or Moncrieff's, requires no fall, the sewage simply flowing in below and flowing out above."

A. Yes, but the pages given are those of the 1783
first edition of the book, May, 1900, while the language quoted in XQ. 123 is from the second edition, published in 1901.

Adjourned to Thursday, June 29, 1905, 10:30 A. M.

New York, June 29th, 1905, 10:30 A. M. 1784

Met pursuant to adjournment.

Present, counsel as before.

Re-Direct Examination of Mr. Snow Continued.

R-d-Q. 238. So far as regards the statement contained in the first sentence quoted from M. N. Baker's book, in XQ. 124, does not the author

1785 appear to have overlooked Mouras' exploited process, or what is your view of this? A. Yes; in Mr. Baker's own paper in the Engineering News, of April 15, 1882, hereinbefore quoted, the liquefying process was described in connection with Mouras' apparatus. The said statement above re-
1786 ferred to of Mr. Baker's overlooks Pasteur's theory of anaerobic action as applied by Mouras and Muller and Scott-Moncrieff, and Adeney abroad, and by Waring, Phillbrick and others in this country.

R-d-Q. 239. Are the following excerpts from Barwise's book, referred to and quoted from in
1787 XQ. 125 (p. 87)?

"During the last seven years the attempts of the earlier experimentors to avoid the necessity for precipitation by causing the suspended organic matter in sewage to become liquefied by the action of bacteria, have been brought to a successful issue.

It was well known that an ordinary cesspool did not require emptying as often as it should if the solid maters poured into it accumulated; and as
1788 long ago as 1881, M. Mouras invented a closed tank in which foecal matter and kitchen refuse disappears as gases, or were transformed into a homogeneous, slightly turbid fluid, this result being due to the fact that animal dejecta contains the ferments necessary to liquefy them.

"M. Mouras and his system, in this country at any rate, attracted little attention, and it was not until the nineties that Scott-Moncrieff brought for-
1789 ward his scheme o liquefy sewage by the aid of the bacteria natural to it. It was left, however, to Cameron, of Exeter, to be the first to successfully deal with the sewage of a town, by first liquefying the sewage and then oxidizing or nitrifying it on bacteria beds. Cameron did more to rivet public attention on the new aspect of the sewage problem than anyone else, by boldly calling his tank a 'septic tank,' thereby calling attention to the fact that

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purification was effected by encouraging the growth of microbes rather than by killing them. There is not doubt that the word 'septic,' in connection with the process of purification, took hold of the public imagination, and extravagant ideas prevailed of the purification which was effected in septic tanks.

"The exaggerated popular notion was that 'the microbes ate each other up, and nothing but innoc- 1791
uous fluid remained.'

"Mr. Adeney, of Dublin—to whom we owe the word 'bacteriolysis'—has suggested that the purification of sewage could be effected by the action of micro-organisms by adding a sufficient quantity of nitrate of soda to the sewage.

"Dr. Sims Woodhead found that in 1 c. c. of Exeter crude sewage there were one million organisms which were anaerobic, or did not grow in the pres- 1792
ence of air, 5½ millions organisms which were aerobic, or did live in the presence of air. Of the one million anaerobic, 300,000 were found to be liquefying organisms; and of the 5½ million aerobic, 500,000 were also found to be liquefying; so that the proportion of liquefying organisms was found to be greater among the anaerobic than among the aerobic.

"The credit for first applying, on a practical 1793
scale, the knowledge of the bacterioligists, that certain organisms had this power of liquefying organic matters, belongs to Scott-Moncrieff, who, in 1891, liquefied the sewage from a household of ten persons by means of a continuous upward flow tank filled with coarse flints. It was five years later that Mr. Cameron, of Exeter, introduced his septic tank."

It is well known that many bacteria have 1794
the power of liquefying solids albuminous matter; in fact, one of the ordinary methods of distinguishing different species of bacteria is to ascertain their action upon such substances as gelatine. As many as 196 varieties out of 440 well-known bacteria have this property of liquefying gelatine."

(Page 89):

"Following on Cameron's Exeter experiments came the investigations of Colonel Ducat and Mr. Didbin. Their experiments were very similar . .

"In either case, solids in suspension are arrested in the upper layers of the filters, where they are gradually liquefied.

1796 "The question at once, therefore, arises, is any form of septic tank necessary? If it is necessary, do any advantages attach to the closed form connected with the name of Cameron, of Exeter?

"Perhaps the best and most authoritative experiments on purifying crude sewage, both before and after screening, with and without septic tank, are those conducted by the Corporations of Leeds and Manchester."

1797 (On page 96):

"As a result of these Manchester experiments open septic tanks have been tried in many places, and, provided that care is taken to properly submerge inlets and outlets, and to have the tanks constructed with efficient scum-boards, the solids in the sewage are liquefied as thoroughly as in a closed tank. . . . .

"As experience has proved the sludge does
1798 accumulate, the tank should be so designed as to permit of its ready removal. . . . .

"In addition to sewage being capable of liquefaction in closed and open septic tanks, it may be liquefied in the manner originally advocated by Scott-Moncrieff, namely, by upward filtration through tanks filled with coke breeze clinker, or other hard material. . . . .

"As a liquefying arrangement, however, an anae-
1799 robic bed acts well, and has its place in the scheme of biological purification."

A. Yes.

R-d-Q. 240. As quoted above, Barwise says that:

"As experience has proved that sludge does accumulate, the tank should be so designed as to permit of its ready removal."

Have you any special information on this subject? A. Yes. From the "Royal Commission on Sewage Disposal. Interim Report. Volume of Appendices, 1902," a copy of which has been here produced. I have extracted certain data and put them in form of a table which I herewith
present. They show "Experiments on Treatment 1801
of Sewage in Closed Septic Tank and Contact Beds" and "Open Septic Tank and Contact Beds." In this table the name of the place is given, the population thereof, water supply in gallons per capita, dry weather flow of sewage, capacity of septic tank, and number, facts as to
accumulation and removal of sludge from the 1802
septic tank, duration of the experiment, number of gallons of sewage treated daily, the officer in charge of the experiments, and facts as to whether the filter beds connected with the septic tank accumulate sludge and "sludge-up."

Referring to this compilation, I will call attention to the fact that there are eighteen places
noted that the average population is 188,000, the 1803
least being 80, and the greatest 1,670,000, and the average volume of sewage treated being 268,000 gallons in eleven places. In all the cases cited the filter beds were reduced in capacity by the accumulation of solids passing out of the septic
tanks, and in all of the septic tanks where observations were made and the experiment had been 1804
sufficiently conducted there were accumulations in the tank.

Counsel for defendant offers in evidence the table referred to by the witness in his foregoing answer, and the same is marked "Defendants' Exhibit Data Com-

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piled from Royal Commission on Sewage Disposal Interim Report Vol. of Appendices, 1902, by F. Herbert Snow."

R-d-Q. 241. Referring to XQ 126, what is the difference between a septic tank and a cess-pool, and
do you agree with Mr. Folwell's definition? A. I
1806 do not agree with Folwell. The old-time cess-pool
was commonly understood to be a receptacle either
tight or having loose walls through which the liquid
would percolate, built in the ground and covered
over, having an inlet for the sewage to flow in, but
no outlet for the sewage to flow out. The liquid
and other matters would accumulate therein until
1807 the tank filled, and then it would either overflow
on to the ground above, or have to be emptied by
baling out or pumping. The septic tank is an entirely different structure. It is an intercepting
chamber, interposed somewhere in the line of flow
of sewage, so that in flowing into and out of the
tank, the solid matters are intercepted therein.
1808 There have been many misapplications of these
terms by those not wholly competent through experience in the art and acquaintance with the literature thereof, to properly use these terms. And inadvertently, even prominent writers have misued
these terms.

R-d-Q. 242. Referring to XQs. 161 and 162, were
1809 the objections to cess-pools overcome by Mouras,
Phillbrick, Waring and others, prior to the Cameron patent in suit? A. Yes. The apparatus of Mouras, Phillbrick, Waring and others, were not cess-pools, but septic tanks, being intercepting chambers interposed in the line of the flow of sewage through which, in passing into and out of the

intercepting chamber, the sewage was separated
into two parts, the solid portion thereof being left
in the tank where it dissolved to a greater or less
extent, and the liquid portion flowing away out of
the apparatus.

R-d-Q. 243. In XQ. 188, an extended quotation
is made from your testimony in the Pawtucket case 1811
in reference to Glover's cess-pool, &c., if you wish
to add anything further on this subject, please do
so at this time? A. While it is true that the cess-
pools were built of loose stone, so that the liquid
would percolate into the adjacent ground, which
was gravelly, which would imply that there might
not be any liquid standing in the tank, for some 1812
reason which I should have to infer, the first cess-
pool which I have hereinbefore designated as a sep-
tic tank, acted as such. During the numerous times
which I inspected it, it contained floating scum
above the inlet and outlet of the tank, resting upon
the liquid, and in its operation the tank acted the
same as it would, had the sides been cemented up.
I can only conclude from this that the ground had 1813
become so waterlogged, or otherwise clogged, as
to act as a substitute for tight walls so built. One
reason why the second or overflow cess-pool was
built was because the first one acted like an ordin-
ary water-tight cess-pool and had to be pumped out,
but after the second one was built, the first cess- 1814
pool became a septic tank and the second cess-pool
the one from which the liquid had no means of out-
flowing, except to percolate through the ground.

R-d-Q. 244. Referring to XQ 139, how do you know there was septic action in the Lawrenceville plant? A. Because I personally examined the operation of that plant an ascertained for myself, and

1815 furthermore I find my opinion was corroborated by that of Mr. Croes, the designer of the said plant in his address at Lakewood, New Jersey, hereinbefore mentioned by me in my answer to question R-d-Q. 217.

R-d-Q. 245. Referring to XQ. 142, and similar
1816 questions,. please make tracings of the inner lines and the inlets and outlets and water level of the tank of the Cameron first British patent, and the tank of the Mouras U. S. patent, and compare the two tracings and features shown therein? A. I have made a tracing of. Mouras' tank, 1882, and Cameron's tank, 1895, and entitled the same, "Mour-
1817 as and Cameron's Tanks, Tracing by F. Herbert Snow, June 29, 1905." Both have an inlet consisting of one pipe only, turned down below the surface of the liquid, and both have one pipe outlet at the opposite end of the tank from the inlet end, said outlet pipe extending down into the liquid below its surface.

1818 R-d-Q. 246. Referring to XQs. 156 to 160, what changes would a sanitary engineer, in the exercise of his ordinary skill and judgment, naturally make in using the apparatus of the Phillbrick or Waring, or the Mouras patent, as a septic tank on a large scale—say as large as the Saratoga plant? A. He would do those things which had been common in
1819 the art for a good many years where tanks have been built on as large a scale as at Saratoga, in fact, the things that were done in the Saratoga tanks; that is, make the depth thereof sufficient to allow for proper sedimentation and retention of the deposits on the bottom of the tank, permitting thereby the supernatant liquid to be drawn off without disturbing said deposits, and also provides sufficient depth

so that the floating matters would remain on the
surface and not be disturbed by the drawing off the
liquids between the floating matters on the top and
the deposits on the bottom of the tank. In these
respects, there would be no change from the Phill-
brick or Waring or Mouras apparatus, so far as the
elements are concerned, because they were included 1821
in the said apparatus, but the dimensions of the
tank; that is, the length, breadth and depth, would
be adjusted to meet local requirements, which ad-
justment has always been common in the art of the
use of tanks. In conducting the sewage into the
tank at mid-depth and out of it at mid-depth, on a
large scale, which elements were contained in the 1822
Phillbrick, Waring and Mouras apparatus, the en-
gineer in the exercise of his ordinary skill, would
adopt those means which had hitherto been used in
the art, such as conduits, extending the whole width
of the tank and having a slot or series of openings,
or by partitions, dwarf walls, baffle or scum-boards,
among which were chosen the means used in the
Saratoga plant. 1823

> Counsel for defendants offers in evidence the tracing made by Mr. Snow and referred to in his answer to R-d-Q. 245, and the same is marked “Defendants' Exhibit, Mouras-Cameron Tanks, Tracing by F. Herbert Snow, June 29, 1905.” 1824

R-d-Q. 247. If asked to sum the matter up in a few words, what can you say as to whether Cameron made any advance in the art through the patent in suit over the previous work of Waring, Phillbrick, Mouras and others; and if he made any advance, please describe it as briefly as possible, and

state whether it was of an inventive character, or mechanical merely? A. I do not understand that Cameron invented or discovered a process. The use of a slotted pipe in the tank was novel, so far as I am informed, and in the other claims of the patent in suit not in issue in this case, various me-
1826 chanical appliances are described which are novel, so far as I know and can state, at this time. Further than this I have very fully answered the scope of the question in my answers hereinbefore, and I will again state that to Mr. Cameron is due the distinction of having first applied the well-known process of liquefaction, previously utilized and fully
1827 described in publications in several countries in connection with household or institutional use, to municipal use on a large scale.

R-d-Q. 248. Were any special changes required in thus enlarging the use of the process of liquefaction—that is, did the process continue the same when applied to towns or cities as it was before when applied to houses or institutions? A. It
1828 was exactly the same process.

R-d-Q. 249. In XQ. 174 you were asked about your Pawtucket testimony, particularly in reference to there being no purification in a septic tank. The Cameron patent in suit states that the,

> "object of the invention is to provide an artificial method and apparatus for the liquefaction and
> 1829 purification of sewage;"

and that

> "the process of purification comprises the subjection of the sewage to the dissolving action of anaerobic bacteria and subsequently to exposure to air and light."

In view of this, I now ask what further you said in your Pawtucket testimony about purification in

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a septic tank; and in this connection you may make any comments or statements considered necessary. A. I will quote from page 409 of my Pawtucket testimony:

"XQ. 144. On page 422 of the State Board of Health Report for 1889 it is stated to be strongly indicated 'that the greater the amount of organic 1831
matter in sewage and in the septic tanks, the greater will be the percentage reduction of organic matter by the tank treatment.' Is not this brief statement and does it not involve partial purification of sewage. A. This quotation is correct, but the reduction of the organic matter in the tank by bacterial action while it reduces the amount of organic matter does not accomplish this by a purifying process, and hence this process is not considered as a purify- 1832
ing one, either in whole or in part.' If the question relates to the fact of a partial purification being accomplished as distinct from the definition or use of the word purification as applied to the action in the tank, my answer would be in the affirmative.

"XQ. 145. On page 426 of the 1899 Report, it is stated, is it not, that at Lawrence, except for bacterial action within the tank, the twenty-six months of operation would have filled the tank five times, 1833
and that instead of that result there was only a small amount left in the tank? Did not that also constitute partial purification of the sewage? A. The statement is correct and the operation of the tank comprised a partial purification of the sewage, using the word purification as a layman might use it and not in the sense in which the word is used in the art of sewage disposal."

The patent in suit, as I understand it, makes the 1834
same distinction as I made in the Pawtucket case and now wish to make again, that is, that the process of purification, comprises, when a septic tank is used for the purpose described in the patent in suit, two parts; first, the subjection of the sewage to the dissolving action of anaerobic bacteria, and second,

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subsequently the subjection of the effluent to exposure to air and light; that is, purification is not effected in the septic tank.

R-d-Q. 250. Referring to XQ. 190, does the form of the apparatus have anything to do with septic action, or rather, will such action occur in a sub-
1836 stantial degree, for instance, in the bed of a stream? A. Substantial septic action does often occur in solids in the bed of streams. This proves that a structure, such as those hereinbefore mentioned, are not necessary for septic action; in other words, no particular form of structure is necessary to septic action.

1837 R-d-Q. 251. Referring to XQ. 195, what about the non-putrefaction of effluent from the septic tank which you mention? A. In answering this question, I will refer to my answer to XQ. 199, which relates to the same case, and in relation thereto I will refer to page 389 of the 1901 Report of the Massachusetts State Board of Health, in which it is stated
1838 that in order that a stable effluent may be produced, it is only necessary that sewage shall have been for a comparatively short period of time in thin layers in contact with an abundance of air, and that aerobic bacterial life, shall have been active without the added straining out of organic matter obtained by sand or other filters of fine material. This re-
1839 lates to rapid filtration, or otherwise, such as was referred to in the said Adeney patent, and supports my statement that a non-putrefactive effluent from the said tank, either filtered or unfiltered, would not be inconsistent. The aeration to render the effluent non-putrefactive, might be obtained in a river into which it flowed.

 1840

R-d-Q. 252. Why have you not employed a preliminary aerating of the sewage, as suggested in XQ. 207. A. Because I have never found it necessary.

R-d-Q. 253. Why was the Adeney subsidence and incubation tank effluent of the third method filtered? A. I should say because without this filtra- 1841
tion the inventor thought that the tank effluent would be unsuitable for discharge into a river, &c., which would be the case undoubtedly where the effluent from the septic tank would be discharged into a small stream of water of insufficient oxidizing capacity.

R-d-Q. 254. In a number of places in the cross-
examination, particularly in questions 55 to 57, 1842
you were asked about ten plants constructed by your firm since 1897, I now ask you whether you or your firm constructed any such plants before that year. If so, please state fully, giving time, place and other particulars? A. It is absolutely impossible for me to answer this question, for this rea-
son, that during the years 1890 to 1898, in which 1843
I was serving as City Engineer of Brockton, Mass., I was consulted by a good many people who sought my advice with respect to the introduction of the Phillbrick, Waring apparatus. I rendered them such assistance as I could in consultation, but was too busy with the manifold duties of my office to
attend to the detail of the construction of such 1844
plants, and I can not say how many, if any of them were built. In my answer to XQ. 76, I referred to a tank constructed by me prior to 1897, which had a non-disturbing inlet and outlet for the purpose of promoting septic action. The tank I had in mind is the one I built in, I think, 1894, after the Waring-

Phillbrick type, at the residence of A. C. Thompson, Brockton, Mass. Mr. Thompson was an intimate acquaintance and in this instance, as a personal favor, I not only designed the plant, but personally purchased the material, laid out the work on the ground and superintended its construction
1846 and operation. This was an intentional use by me of septic action. The tank was constructed in the yard and connected with the main drain of Mr. Thompson's private residence, serving only the members of his household. It was kept in operation, as near as I can recollect, about two years, until a sewer was built in the street, upon which
1847 Mr. Thompson's estate abutted, when the disposal plant or tank was abandoned, and the property connected with the street sewer. During these two years the tank worked successfully and did all it was designed to accompish.

R-d-Q. 255. In what respect and to what extent did this tank which you constructed for Mr. Thompson, embody, apply or carry out, the septic tank
1848 process described in the Cameron patent in suit? A. It carried out the process to the full extent. That is, it liquefied the solids so that the tank did not have to be cleaned out, so far as I know, and I frequently observed its operation.

R-d-Q. 256. Was that plant which you constructed for Mr. Thompson, used openly in the ordinary
1849 course and how many people knew about it, giving names and present addresses, so far as you know? A. There was no secret use of the process. It was similar to hundreds of installations in the vicinity of Boston and everywhere in the country. I have hereinbefore quoted from Waring's book and Phillbrick's book which state that hundreds of these

 1850

tanks had been in use. I do not know anyone but Mr. Thompson, to whom I can positively refer as having known the facts as to the design, construction and operation of this plant, Mr. Thompson's address is A. C. Thompson, Brockton, Mass.

Recess.

R-d-Q. 257. If you have anything here present 1851
published by Colonel Waring, relating to this subject, additional to what has already been referred to, please refer to the same and quote therefrom as you consider necessary? A. I have what appears to be a re-print from the "American Architect and Building News," of an article by Mr. Waring, entitled, "Sewage Disposal for Isolated Houses," in 1852
which, under the heading, "Cleaning the Settling Chamber," appears the following:

"It is desirable to remove the deposits of the settling chamber from time to time, as observation may show to be necessary. No rule can be given as to this. In some cases, the decomposition is so complete that the chamber never accumulates much deposit. In others it should be cleaned out monthly. The proper relation between size of 1853
chamber, amount of water discharged, and proportion of foreign matter in the water can not be fixed in the present state of experience with the apparatus."

The date of this pamphlet is not given, neither is the name of the printer thereof. On the cover are these words, "Greenwich Construction Company. System of Sewage Disposal for Isolated Houses." 1854
"Patented August 29, 1876; December 23, 1879; January 27, 1880. Applications have been filed for further improvements." Within the pamphlet I find, under the heading, "Patented Details," covered by the patents and applications referred to, "The interposition of a Grease-trap or Settling

Chamber between the Flush-Tank and the House, to hold back solid matters until dissolved or mascerated."

Re-Cross Examination of Mr. Snow by Mr. Gifford:

> The right of objection having been re-
> 1856 served, complainant's counsel now objects to all alleged prior uses set up in the foregoing testimony, on the ground that the same are not pleaded in the answer.

R-X-Q. 258. You have stated (Ans. 231), that the Cameron system "came heralded as a new process, a wonderful discovery, and the beginning of a
1857 new epoch in sewage disposal." But you have stated that this was because it was "backed up by patents. judicious management, and fortuitous and extensive free advertising." What do you mean by "free advertising" in this instance? A. References in debate, and discussions of papers read before scientific societies and by word of mouth, which obtained in this country with respect to Cam-
1858 eron's claims, and public discussions, oral and otherwise, elsewhere, all of which was in fact a most extensive free advertising of Mr. Cameron and his claims.

R-XQ. 259. By whom were such papers read and before what societies and by whom were such debates and discussions carried on? A. There were
1859 two public inquiries made at Exeter, by the officers of the local government Board, in May and November of 1897, which were a matter of public importance. Certain facts were made public at this time with respect to the process and claims therefor, which I think were the basis for the discussion, debates and conversations between individuals in

 1860

America, to which I have above referred. I recall having read in an English publication of many debates and discussions of papers, and of comments by the press on the Cameron system. They preceded similar discussions in America. What we got here was second or third hand, at first. I know that
I was conversant with the Exeter system in 1898 1861
to the extent that I prepared and read a paper for the State Association of Engineers of Indiana, which paper appears in the Annual Report of that Society. I do not now recall the date or even the title of the paper.

R-XQ. 260. By whom were the debates and dis-
cussions and comments of the press in England, to 1862
which you have referred in your last answer, on the the Cameron system in 1897? A. By engineers, chemists, bacteriologists and public authorities, as near as I can recollect now. I can give names and dates and publications later, if you wish.

R-XQ. 261. In his testimony in the Pawtucket
case, Professor Folwell said (p. 145), as to the 1863
Cameron process:

"The process was observed by a commission in 1897 and their conclusions published in that year in England. The first publication in this country making any reference to this septic tank which I can find is that of the Engineering News of New York City, on January 13, 1898. During the same month a paper describing this tank was read before
the Brooklyn's Engineer's Club, but was not 1864
printed in their publications until several months later. In the March, 1898, number of the Journal of the American Chemical Society Professor Kinnicutt gave a description of this tank. The 1898 Report of the Massachuetts State Board of Health refers to this process, but this Report did not appear until the later part of 1899. The most, if not all, that of these American publications were due

to visits made to the Exeter tank by engineers from the United States."

So far as you know is that statement so far as it goes in accordance with the facts? A. Yes.

R-XQ. 262. Then, as I understand you, when in answer 231 you attributed the fact that the Camer-
1866 on system "came heralded as a new process, a wonderful discovery, and the beginning of a new epoch in sewage disposal," to "extensive free advertising you did not mean advertising in the ordinary sense of advertisement for commercial purposes? A. No.

R-XQ. 263. Might what you have termed "free
1867 advertising" be truly termed the spontaneous discussions by engineers in this art, which arose spontaneously upon the publication of the Cameron Exeter tank and the results obtained thergeby, such discussions not having been sought by Mr. Cameron? A. Yes.

R-XQ. 264. If practicable, will you bring with
1868 you to-morrow, the publication of your 1898 paper in reference to the Cameron system? A. I will.

R-XQ. 265. What was the date of your examination of the Lawrenceville plant, referred to in your answer 244, and also of the address of Mr. Croes, referred to in the same answer? A. The date of Mr. Croess' address was November 4, 1903. I ex-
1869 amined the Lawrenceville plant during the Winter of 1903-4.

The testimony of this witness as to the statement of Mr. Croes, is objected to by complainant's counsel as hearsay.

R-XQ. 266. Turning to your 212th answer, where you say the total area of the 96 outlet holes in the

 1870

Saratoga septic tank is designed to be sufficient to conduct away from the tank a volume of effluent equal to any flow of sewage into the tank. Why is the total area of these holes limited to an equality with the maximum flow of sewage into the tank; why are they not made larger? A. Because there was no need of making the area larger. And in 1871
making this reply the answer is relevant to the inlet as well as the outlet. I mean by this that if there was any reason to make the inlet larger, that same reason would apply to the total area of the outlet holes.

R-XQ. 267. Returning now to the language of one of the three claims (6, 7 and 8) which you point 1872
out as being those that in your opinion are not infringed (answer 208) I understand that the particular word in Claim 7 to which, in your opinion, the Saratoga plant does not conform, is the word "slot." In other words, if the words "series of perforations" were substituted for the word "slot" in Claim 7, it would be made to conform with the 1873
Saratoga plant; is that correct? A. Yes, my answer now referring to Claim 7 only.

R-XQ. 268. What difference would it make to the operation of the Saratoga plant, whether the outlet be a series of perforations open across the greater part of the width of the tank, or be a slot, providing the total area of the perforations and of 1874
the slot be equal? A. This difference, that the slot would cause more agitation than the said perforations, the perforations being, in my opinion, the ideal way of conducting the effluent away from the tank with the least possible agitation.

R-XQ. 269. Do you think that the difference in

1875
agitation between that produced by an outlet con-
sisting of a series of perforations and that produc-
ed by a slot of substantially the same area, would
be sufficiently substantial to be considered import-
ant, and if so, in what way would its substantial
importance show itself in the results produced? A.
1876 Allowing for an accumulation of sludge of the
thickness of 24 inches on the bottom and an accu-
mulation of floating material of the same thickness
on top at the outlet end of the tank, there would
be in the Saratoga tank practically four feet of
intervening liquid, and by a slot located half way
in this liquid there would be a vertical movement
1877 from the scum downward and from the sludge up-
ward, concentrating in an increased velocity at the
slot, while if there were a series of openings arrang-
ed, as in the Saratoga plant, then this concentra-
tion would not be nearly as great; in fact it would
be entirely obviated. The greater the agitation, of
course, the greater the amount of solids that would
1878 pass from the tank with the liquid.

R-XQ. 270. The words of Claim 8, to which you
think the Saratoga plant does not conform, are "an
outlet consisting of a pipe extending across the
greater part of the width of the tank and disposed
above the bottom and below the normal water level
thereof, said pipe having an opening in its wall
1879 throughout its length for admitting the effluent."
If in place of the word "pipe" wherever used in the
above quotation, the word "conduit" were sub-
stituted, would this Claim 8, then, in your opinion,
conform with the Saratoga plant? A. No; because
the Saratoga plant does not contain a conduit or
pipe outlet in the tank.

 1880

R-XQ. 271. Then, as I understand you, the reason why you deny infringement of Claim 8, is because the pipe or conduit into which the effluent of the tank flows primarily, is in the Cameron patent located within the end wall of the tank, while in the Saratoga apparatus it is located outside of said end wall; is that correct? A. That is one of 1881
the reasons; and the further reason also that were the conduit located within the tank, it would not be a pipe having an opening in its wall throughout its length.

R-XQ. 272. I now turn to Claim 6, which in answer 208 you said was not infringed, because of the limitation imposed by the words "settling 1882
tank," is the force main between the pump and the septic tank at Saratoga level its whole length, and if not, how does it depart from the level? A. The force main is laid with an ascending grade to a point about 4,400 feet from the pumping station, where a 4 inch air vent rising above the hydraulic radiant is placed. From this point it drops to a 1883
water course, where there is a blow-off, and then rises continuously to the septic tanks. It can be drained either to the pumping station or the blow-off.

R-XQ. 273. How steep is the ascent of this force main at Saratoga from the blow-off to the septic tank? A. I cannot state from recollection. The 1884
level of the water in the septic tank is 18 feet above the lowest elevation in the pump well of the water there.

R-XQ. 274. The drawing that you have produced of the Saratoga tank, particularly the figure marked "Section on line A-B," shows the force main as

emptying into a well, from which well the sewage enters the pipe leading to the septic tanks. As I understand it, the point at which this pipe leaves the well, is above the bottom of the well; is that so? A. The force main enters a chamber at the bottom thereof, and the pipes leading out of the chamber
1886 to the tank is above the bottom of this chamber.

R.XQ. 275. How far above? A. About two feet and a half.

R-XQ. 276. I have here a publication entitled "Journal of the Association of Engineering Societies," dated February, 1905, and in it is an article entitled "The Sewage Disposal Works at
1887 Saratoga, N. Y., by F. A. Barbour, Member of the Boston Society of Civil Engineers." Is that the Barbour that you have referred to in your testimony as your partner? A. Yes.

R-XQ. 277. Will you verify the correctness of the statements in this article? A. Yes.

Complainant's counsel offers in evi-
1888 dence the article last referred to and the same is marked "Complainant's Exhibit Barbour on Saratoga Plant."

R-XQ. 278. Will you please continue your answer to XQ. 213, so as to include claims 20 and 22? A. With respect to claim 20, this covers a non-disturbing inlet and outlet, both with
1889 branches or broadened mouths, and submerged, with means for excluding air and light. I will refer to the following:

British patent No. 7134 of 1887, to Gurtler.

U. S. patent No. 505,166 of 1893, to E. O. Meyer.

British patent No. 364 of 1870, to Wigner, and to Austin's proposed tank, and to the Tanks at

 1890

Clifton Union, referred to in Austin's book. And prefer to have them considered as approximations in their respective order.

With respect to claim 22, which provides for a submerged inlet and outlet in an enclosed structure excluding air and light, since the question excludes from my answer the tanks used as septic 1891
tanks, but includes only settling tanks, I cannot mention the many examples hereinbefore stated of apparatus embodying the elements of this claim with the word 'septic'' stricken out. But I will cite as approximations the references given in regard to claim 20.

R-XQ. 279. May the references cited in your 1892
last answer, and in answer 213, and the claims to which in those answers you have cited them, be tabulated as follows:

Smith, Eng.		to claims	...	5 6 7 8 11 12
Pow, Eng.		" "	...	5 7 8
Walker, Eng.	232	"	...	6
Walker, Eng.	2329	"	...	6 7 8 11 12 1893
Denton,	"	"	...	6
Gurtler,	"	"	...	7 8 20 22
Wigner,	"	"	...	11 12 20 22
Wigner U. S.		"	...	6
Hille U. S.		"	...	6
Wilcox U. S.		"	. .	6
Mitchell U. S.		"	...	7 8 1894
Moore, U. S.		"	...	11 12
Burnham		"	...	6
Frankfort		"	...	6
Cheltenham		"	...	7 8
Clifton		"	...	11 12 20 22
Austin		"	...	7 8 11 12 20 22

1895 F. Herbert Snow.

A. The Wigner English patent was cited in respect to claims 11 and 12 and not the U. S. Wigner patent as shown in the above table. Meyer U. S. patent was cited in respect to claims 5, 7, 8, 11, 12, 20, 22. Worcester to claims 7 and 8.

With these corrections and additions the table
1896 is correct.

R-XQ. 280. Please mark by the reference letter X on the drawing of each of the references mentioned in the last answer, the particular tank in each reference that you refer to as embodying or approximating the subject-matter of the claims against which you cite it; also please mark the in-
1897 let into each tank with the letter X, and the effluent outlet therefrom with the letter X2.

Adjourned to Friday, June 30, 1905, 10 A. M.

New York, June 30, 1905, 10 A. M.

Met pursuant to adjournment.

Present, counsel as before.

Re-Cross-Examination of Mr. Snow Continued.

1898 A. (to R-XQ. 280) I have done this.

R-XQ. 281. Of all the tanks that you have referred to, in the prior art, state which ones you consider to be the closest resemblance to the tank shown in the Cameron patent in suit, having regard not only to the form of the tank, but also to the outlet and inlet openings. In answering this
1899 question please make no distinction between settling and septic tanks. A. It is difficult for me to arrive at a conclusion in answering this question. I will mention British patent No. 3562 to Thomas Smith, although there is not much choice, if any, between this and others.

R-XQ. 282. And which of the three tanks that

 1900

you have marked X on the drawing of that Smith patent do you select in answer to the last question? A. The first large tank, which is referred to in the patent as *d*.

The right of objection having been reserved, complainants' counsel now objects to answers 254 and 255, and 256, 1901
and 224, 225, 219, 217, as hearsay and incompetent, insofar as they contain any matter not shown by patents or publications in evidence and duly proved as prior to the patent in suit.

R-XQ. 283. Is the following an excerpt from the Waring pamphlet, referred to in your answer 1902
257:

"It is now clearly and generally understood that the all-prevailing cesspool used for the disposal of household waste is in every respect pernicious and objectionable. It would hardly be too strong a statement to say that the best cesspool is worse than the worst sewer;—even when water-closet matter is excluded, the condition is not much improved. 1903
Thus far the cesspool has been the only means of disposal generally available where there were no sewers.

"The slowly growing and carefully matured experience of the past fifteen years has, however, demonstrated the success of the system of sub-surface irrigation, or the disposal of foul liquids by open-jointed drain tiles laid near to the surface of the ground—within reach of the roots of vegetation 1904
—as not only a very great improvement on the cesspool but as being in fact as nearly perfect as the conditions of the case will probably allow."

And as to that portion of the Waring sub-surface irrigation apparatus that you have referred to as a septic tank, does said pamphlet contain the following:

1905 "It is in fact a perfect system for the disposal of
household waste, practically and theoretically,
with a single limitation, viz.: It still involves the
retention of a cesspool of very limited size. It is
impracticable to allow the discharge of kitchen and
water-closet matter, including paper, to flow
directly into the flush tank; it would soon obstruct
1906 the siphon and so much of it as passed on into the
drain would soon obstruct these. It is imperative
that such matters should be withheld until by mac-
eration or decomposition they will pass on in solu-
tion or in suspension in the liquid flow. In so far
as decomposition is necessary the settling basin is
in a less deegre subject to the theoretical objec-
tions that are made to the cesspool. It is how-
ever to be considered that this settling basin, which
1907 is perfectly tight as to its walls, is so small that
the volume of water passing through it takes up the
products of decomposition and carries them on to
drains before they assume a condition at all com-
parable with that of the permanent cesspool. It is
found practically that the arrangement is inoffens-
ive and safe."

A. Yes.

1908 R-XQ. 284. In the Thompson apparatus that
you refer to in answer 264, what was the size of
the tank which you state was for the purpose of
promoting septic action? A. It had, I think, a
diameter of six feet and a depth of water or sew-
age of about three feet, the septic tank being di-
vided by a division wall into two equal parts, and
1909 having a submerged inlet and a submerged outlet
to the tank.

R-XQ. 285. Was it substantially the same interiorly as the diagram marked "Waring 1892" on "Complainant's Exhibit Tracings Prior Art Systems?" A. Yes.

R-XQ. 286. Then the chamber on the outlet

1910

side of the division was a semi-circle of about three feet in radius? A. Yes.

R-XQ. 287. Is the division wall that you have just referred to that which in the Waring pamphlet entitled "Sewage Disposal for Isolated Houses," and referred to by you in answer 257, described as follows: 1911

"It was found, however ,when it became a question of disposing of the entire waste of a house, including water-closets, baths, etc., that the flow into the settling basin had at times different force to so disturb its deposists as to cause a considerable amount of semi-solid matter to pass over into the flush tank, leading in time to the obstruction of the drains. This has been remedied by construct-
ing in the settling basin a division wall at right 1912
angles to the line of flow and built to about the height of the ordinary water-level. This wall dividing the basin into two chambers, confines the disturbance caused by the inflow to the first chamber. The flow from this into the other chamber being in a thin stream over the top of the wall does not disturb the deposit and only the liquid passes into the flush tank."

A. Yes. 1913

R-XQ. 288. What was the date of Mr. Cameron's first public statement about his septic tank, which you have stated in answer 222 to have been his testimony before the Royal Commission? A. The date of that testimony was October, 1898, but that was not his first testimony before a public
hearing. He appeared before the Local Govern- 1914
ment Board the year previous, but I have now nothing before me to show what his testimony was at that time.

R-XQ. 289. Where did you obtain the information about Cameron's Exeter septic tank experiments set forth in your answer 221? A. In

1915

the Report of the Royal Commission on Sewage Disposal, hereinbefore mentioned.

In view of the last answer, answer 221 is objected to as incompetent and hearsay.

1916 Recess.

R-XQ. 290. In answer 223 you mentioned "The chemists and bacteriologists who had been called in to examine and report on what was being accomplished in the Exeter tank." When were these chemists and bacteriologists called in and who were they, and by whom were they called in
1917 to examine the report on Cameron's Exeter tank? A. Dr. Theodore Thompson, M. D., Medical Inspector under the Local Government Board; Dr. German Sims Woodhead, Dr. Samuel Rideal, Mr. William Joseph Dibdin, Dr. Dupre, Messrs. Tearman and Meor and Mr. Perkins, the Public Analyst. These experts were called in by Mr. Cam-
1918 eron, on behalf of the Corporation of Exeter, and as I understand it, made their reports during the year 1897, to furnish reliable data to present to the officers of the Local Government Board, who conducted inquiries on May 26th and 27th, 1897, and again on November 23rd to 27th, 1897.

R-XQ. 291. Was this the same Dibdin that you
1919 have referred to in your direct testimony? A. Yes.

R-XQ. 292. Have you brought with you the paper that you, in answer 259, said that you read before the State Association of Engineers of Indiana, and if so, what was its date? A. I have the said paper now before me, and it was read before the Indiana Engineering Society at its 19th Annual Meeting, Wednesday, January 25th, 1899.

R-XQ. 293. Are the following excerpts from that paper:

"The organic compounds in fresh sewage are complex and their resolution into organic form may be very slow or it may be hastened by aiding 1921
the bacterial action to break up the organic matters into the simpler forms. In this work there may be said to be two general kinds of bacteria, one the bacteria of decomposition—called aerobes, and the other the bacteria of putrefaction, called anaerobic, some of which can work in the presence or absence of oxygen, and others of which can exist in the absence of oxygen only. The products of aerobic activity are mineral compounds; the pro- 1922
ducts of anaerobic activity are strong poisons of alkalodial nature.

"In fresh human dejecta there are millions upon millions of bacteria of various kinds. Immediately upon the mixing of this matter with the water from the plumbing fixtures of the house, a portion of it is dissolved and held in solution, and the remainder flows along in suspension and the aerobes asisted by the anaerobes commence and continue the work of 1923
food assimilation until the supply of oxygen is consumed, when the aerobes cease their work. The hoardes of anaerobes then have full opportunity for their dangerous activities. Putrefaction sets in in earnest and foul gases are generated.

"Active putrefaction may begin a short time from the entrance of the sewage to the sewer, or it may be postponed until the place of disposal is 1924
reached, depending upon the amount of dilution and the velocity in the sewers.

Mr. Dibdin's method at Sutton, which is attracting so much attention, because of high rates, is, by the use of two sets of tanks, filled with a filtering medium, one coarse and one fine. Into the coarse filter the sewage is flowed after being mechanically screened as perfectly as possible.

From forty to sixty per cent. of the organic matter in solution is removed by the first tank. The effluent is then further purified in the fine filter. The time occupied in filling the first tank is three-quarters of an hour; the sewage is then held for two hours, during which time it is claimed the anaerobes have opportunity to work; the emptying requires an hour and a quarter, and the bed
1926 is then given a rest of two hours. The aerobes are supposed to do their share of the work during this period. Six hours completes the cycle and the charge is again repeated. The clarified sewage is then applied to the fine grained filter. About 900,000 gallons per acre are thus treated. The process in the first tank is claimed to be both putrefactive and oxidative. About eighty-five per cent. of the organic matter is removed by both
1927 tanks.

"Whether these high rates can be maintained indefinitely remains to be seen. The plant has not yet got beyond the experimental stage.

. . . .

Mr. Donald Cameron's septic tank at Exeter absolutely excludes all air and light. The putrefactive bacteria rapidly change the solids into
1928 liquid forms, the gases are not provided avenues to escape, only such as they make for themselves and the contents of the tank is a seething mass of rottenness of the worst kind imaginable.

"It is claimed that the effluent is not more offensive than ordinary strong sewage. How this process would work on a large scale nobody actually knows.

"If you tell the average city or town official
1929 that the new reason for storage of sewage is diametrically opposite to former ones, and conditions are now sought in receptacles which have hitherto been scrupulously avoided, the knowledge will come to him as a startling revelation of the extremity to which a crank is willing to go, to improve on present conditions, and the public is quite likely to look at it in the same light.

When we stop to reflect that the detention of

sewage has only been tolerated to prevent or abate some greater nuisance—for instance, where outfall sewers emptying into tidal waters have been made purposely larger, or reservoirs for the temporary retention of great quantities of sewage have been required, to prevent objectionable matters setting back with the incoming tides and depositing or becoming stranded where they would 1931
cause trouble, or where chemical precipitation tanks have been provided to render the water of some stream or bay less foul, or where storage has been provided to facilitate the application of sewage to disposal areas, in each and every case of which the trouble to be avoided was greater than any annoyance the detention of sewage would likely occasion, and when we stop to still further reflect that these receptacles at best have been objects of constant suspicion and attention, 1932
and that the prevailing idea has always been to hurry away the objectionable matter from beyond the populated district, and places that people frequent, before it had time to do much harm, since obviously sewage kept in motion has the least opportunity to deposit, putrefy and cause trouble of any kind, the difficulty in the way of a rapid adoption of the septic tank method in its most radical form appear formidable. Nevertheless, public 1933
sentiment may have to give away.

"We stand like the child before the teacher. We begin to understand some of nature's ways and apply her laws to our necessities. Some great innovation may mark with distinction the progress of sewage purification in the next decade."

A. Yes.

R-XQ. 294. In answering question 172, what did 1934
you mean by the qualification "I should have to modify the answer if the question involved any structures for the purpose of facilitating nature's process of purification?" Did not question 172 give with substantial correctness the history of house-wastes from the time they leave the house

1935

drain and enter the sewer in the Saratoga septic tank system, for example? A. Yes, in the Saratoga plant, but it would not be true were contact filters used, or were the tanks used as mere settling tanks and the sludge daily applied to filters.

1936 R-XQ. 295. Turning for a moment to the Adeney English patent, you stated in answer 206 that "fresh sewage was better adapted to septic action than stale sewage." I do not understand how this can be so, in view of the fact that you have stated that it is not until the supply of oxygen is consumed and the aerobes cease their work,
1937 that the anaerobes have full opportunity for their
activities and putrefaction sets in in earnest.
Will you please explain? A. The terms "fresh"
and "stale" are relative only. For the purpose
of the answer substituting in the place of stale
the word septic my meaning may be more evident;
that is, a septic sewage may comprise a sewage
1938 in which the hydrolytic changes have been car-
ried to that degree which produces toxins, and in
this condition the further subjection of the liquid
to marked anaerobic environment is known to re-
tard, rather than hasten liquefaction. In fresh
sewage there has been no opportunity for the pro-
duction of products of anaerobic activity, sensibly
1939 inimical to liquefaction, therefore the statement
appearing in the answer referred to.

R-XQ. 296. If the sewage just before entering the Saratoga tank should be thoroughly aerated by converting it into a fine spray by means of an air current, would not the free oxygen thus added to the sewage be the cause of aerobic action

 1940

upon entering the tank? A. I think it would promote the activities of the aerobic liquefying organisms in that part of the tank.

R-XQ. 297. Have you ever tried any experiments to determine how long such aerobic activity would under those conditions continue in a
given portion of the aerobic sewage after entering 1941
the tank before putrefaction would set in in earnest in that portion of the sewage? A. No, no conclusive experiments. I have observed an aerated sewage, after it has passed into a septic pool and a sewage not aerated after its passage into a septic pool, but I do not consider that the
knowledge obtained thereby is relative to the 1942
question as put, because the aeration was not as thorough as that described in the question.

R-XQ. 298. Suppose you were not starting with a septic pool of sewage, but simply with an empty tank, and that you should thoroughly aerate all the sewage that flowed into the tank,
by converting it into a fine spray by means of 1943
an air current. In view of the free oxygen thus added to the sewage, can you say how long the action in the tank would be aerobic or how long it would be before the supply of oxygen would be consumed and putrefaction set in in earnest? A. It would depend very largely upon the quality of
the sewage thus aerated and its capacity to ab- 1944
sorb oxygen . I can state how long it will take a sewage containing free dissolved oxygen to lose that oxygen and become putrid under the conditions named in the question.

R-XQ. 299. In answer 9 you stated:

"In the patent in suit, Figures 1 and 2, 5, 8, 9, 10, 11, only two such pipes 17 are shown in the wall of the outlet end of the tank, thereby concentrating the flow of the tank at two points, whereas in the Saratoga plant the flow is not concentrated out of the tank, but is divided and passes out through 96 pipes."

Is not the concentration of the flow of the tank of the patent in suit at the two pipes 17, prevented
1946 by the following statement of the specification (p. 2, 1, 94)?

"It is necessary to discharge the contents of the tank or vessel along an extended line lest the flow should be concentrated to a point or points of discharge and so stir and carry away the floating matter. The outlet therefore consists of a pipe or conduit 10, which may or may not be
1947 closed at its top, following the line along which it is desired that the contents of the vessel or tank A should be discharged and having throughout its length or a part thereof a slot or aperture by which liquid may enter the said pipe or conduit. Such slots or apertures may diminish in size toward the outlet or outlets from the said pipe or conduit, so as to avoid an excessive rate of flow thereinto near such outlet or outlets, thus main-
1948 taining a uniform flow into such pipe or conduit throughout its length. The slots or apertures may be placed in any position along said pipe or conduit 10 so as to admit liquid into the tank in a downward, upward, horizontal or oblique direction, as may be desired. . . . . The slot or apertures may also be provided with a strainer for the exclusion of solid matter."

1949 A. Yes, when the outlet consists of a pipe with the said graduated slot, as shown in Figure 10 and Figure 11. But most decidedly no, when the outlet conduit is the same as shown in figures 9, 8, 5, 2 and 1, in which figures the outlet conduit is shown to consist of what I call a "partition" or "baffle-board." Parallel to the end wall of the tank and extending down from above the nor-

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mal water level to about mid-depth of the tank,
to a point very near a projection into the tank
and to the line of said baffle board of the said
wall, forming thereby with the baffle board a slot,
and conduit, conducting the liquid from the tank
along the whole width thereof to two pipes 17, ex-
tending through the end wall of the tank. By 1951
this construction I do not understand that there
would be any other than a concentration of flow
at the said outlet pipe 17, although the opening
into the said conduit 10 would extend the greater
or entire width of the tank.

R-XQ. 300. Even in Figures 9, 8, 5, 2 and 1,
would not the outflow through the slot between 1952
the baffle board and projection be distributed
along the whole length of that slot if that slot
were narrow enough to require its whole length
for accommodating the flow of sewage through
the tank. A. Yes, but this flow into the conduit
would be greater at the pipes 17, or near them
than away from these pipes, so there would be 1953
an increased velocity and hence concentrated flow
at these particular points.

R-XQ. 301. Isn't it likewise true that in the
Saratoga plant there was an increased velocity of
the flow through those 96 perforations that are
nearest the outlet from the conduit into which
they lead? A. I think not, to any appreciable 1954
extent.

R-XQ. 302. Do you mean to say that if the slot
in the patent in suit were so narrow as to require
its whole width for accommodating the flow
through the tank that there would be a concen-
tration of the flow through it adjacent to the out-

lets from the conduit into which it leads, but if
the same slot were divided up into perforations,
or were covered by a strainer, such concentration
would not occur? The total area of the apertures
through the strainer or of the perforation being
the same as that of the slot. A. I fear I fail to
1956 comprehend the question. The strainer, I think,
might well be eliminated from the question, be-
cause the apertures or slots would operate the
same with or without it, if the strainer did not
clog up. Obviously, if the slot must be narrow
and the whole width of the tank there would be
greater velocity to it than if the slot were very
1957 wide and extending the width of the tank. If the
outlet conduit, such as is shown in Figures 9, 8, 5, 2
and 1 of the patent, was used in one of the Sara-
toga tanks, the slot or opening being the same
area of the ninety-six holes now used in the Sara-
toga end wall, then I mean to say that there would
be a concentration of flow in the former and com-
1958 paratively none in the latter.

R-XQ. 303. If, instead of the perforations into
the outlet into the Saratoga plant, you should sub-
stitute a slot covered by a strainer, the total area
of the apertures through the strainer being only
sufficient to accommodate the flow through the
tank, why would there be a concentration of the
1959 flow which does not exist with the perforations
existing in the Saratoga tank? A. The strainer
might consist of a sand filter, as the question is
put, and would constitute an impediment to the
flow of the sewage throughout the whole length
of the conduit, would be sure to clog up for parts
of or its whole length, thereby causing a concen-

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tration of flow at one or more points or the cessation of the flow entirely. I therefore fail to comprehend the meaning of the question as put. If by a strainer is meant a structure not intended to strain out the minute particles which pass in the effluent from the septic tank, but a structure with a series of holes, whose office is not to strain 1961
out suspended matters in the effluent, although it may be termed a strainer, then the use of it would be superfluous, and eliminating it from the question, my answer is that a slot being only sufficient to accommodate the flow through the tank, would, for the reasons I have given in my last answer, have a concentration of flow which does 1962
not exist in the perforations existing in the Saratoga plant.

R-XQ. 304. I have always understood that a liquid will endeavor to take the shortest course to its outlet, but if on the way to its outlet it be compelled to pass either through a row of perforations or a slot, the extent to which it will be com- 1963
pelled to distribute itself, either along the row of perforations, or along a slot, will depend upon the rate of flow in comparison with the size of the perforations or slot, the flow in either case being preferably through that part of the perforations or slot affording the shortest course to the outlet, and being compulsorily extended along the line of 1964
perforations or slot as far as the rate of flow requires. If you differ from this statement, will you please state the reason why? A. I will answer by an illustration, the case being that of defendants' plant. The effluent from the tank passes out through a series of holes in two horizontal rows

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extending the whole width of the end wall, into a chamber adjacent to the tank, in which the effluent stands at the same level as the level in the tank. The effluent is drawn from this chamber, not at the bottom or mid-depth, but at its extreme top, by a device called a weir, over which sewage
1966 effluent flows by the force of gravity, there being required an inclination on the surface of the effluent in said chamber to operate this weir. The movement of the water or effluent in this chamber is therefore largely on the surface, because of the size of the chamber and proportions of the weir; hence it follows that there is a very much larger
1967 area to distribute the velocity of flow out of the tank, and the effluent therefrom is not drawn to a sensible degree more rapidly from the openings into this chamber which are nearest the weir, but more uniformly through all the openings into said chamber. While in the case of the conduit in Figures 9, 8, 5, 2 and 1, the effluent is all col-
1968 lected into two pipes, located at the same level with the slots in the conduit and hence there is not as large an area to distribute the velocity in, and necessarily there must be more concentration of flow.

Baffle boards for the purpose cited in the patent in suit of serving as a non-disturbing outlet, have
1969 been used in the art for a long time, and the reason we did not use them at Saratoga was that we considered the series of pipes adopted as preferable and more to the purpose.

R-XQ. 305. In view of your last answer, if everything else remained the same, inclusive of the chamber and weir, to which you have referred in the

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Saratoga apparatus, but a slot should be substituted for the two rows of perforations, such slot being narrow enough so as to require its whole width so as to accommodate the rate of flow, would not the flow pass through the whole length of the slot for the same reason that it passes through the whole length of the opening? A. Yes. 1971

R-XQ. 306. I do not understand your answer 229, which seems to say that in the Cameron tank the solid was removed from the sewage as solid as distinguished from its removal by liquefaction. Do you mean by this that preliminarily to the liquefaction of the solid in the tank it is removed from the liquid in the sense that it setlles to the bottom or 1972
rises to the surface, and not in the sense of being taken out of the tank? A. I meant, first, that there was a grit chamber in the tank to intercept matters of a gritty character, and that among them there were organic matters which in time were bodily removed from the liquid in the tank and from the tank itself. Next, that not all the solid 1973
matters were liquefied, but they were intercepted and gradually accumulated, requiring a consideration of the question what to do with them when the tank became full, or they required being removed as a solid from the tank. Hence, my answer that the Exeter tank removed from the solid as a solid from the sewage as distingished from its removal 1974
by liquefaction.

R-XQ. 307. Do you mean to say that the tank did become full? A. No.

R-XQ. 308. Do you mean to say that liquefaction was not the cause of its not becoming full? A. I can not say whether the septic tank ever filled up or not. If I have known, I have forgotten. If it has ever been cleaned out, it was because liquefaction was not sufficient to dissolve the solid matters.

R-XQ. 309. Do you find the quotations that I made in XQ 123 from Rideal's book, edition of 1901, also in the edition of 1900, from which you have
1976 quoted? And if so, on what page? A. I do. On pages 213 and 214.

R-XQ. 310. And immediately following the first paragraph that I quoted from Rideal in question 123, does the following occur in reference to Cameron's septic tank, and its comparison with such filter tanks as those of Dibdin and Scott-Moncrieff:

1977 "In this way the sewage becomes mixed and averaged, and the bacteria have a chance of working during the passing through the 65-foot length of flow which the sewage traverses at the rate of little more than 2 feet per hour. No obstruction is present, and the entire space is available, differing from what we have seen of tanks partially filled with stones or coke. In the latter the dimensions must either be larger in proportion,
1978 or the sewage must pass at a greater rate, the bacteria also are not so freely distributed through the liquid. From the inspection chamber (in the septic tank) it is seen that a leathery scum from two to six inches thick, according to the position, collects on the surface and renders the whole anaerobic. Below this is a zone of fermentation, in which the sewage is mainly clear, but bubbles of gas keep the liquid in a state of
1979 quiet admixture. At the bottom of the tank there is a layer of the dark faecal matter previously referred to (p. 81), which is so small in amount that during a period of a year's working it does not require to be removed."

A. It does.

R-XQ. 311. Why do you understand that the three or four basins, described in Muller German

 1980

patent, 9792 of 1878, were "lifted out of the ground;" as stated in said Muller patent? A. To admit of their continuous discharge on to the filters.

R-XQ. 312. On your table, marked "Data compiled from Royal Commission on Sewage disposal, Interim Report," have you any personal knowledge 1981
showing that the tanks at Manchester were Cameron tanks in the sense of being constructed by Cameron? A. I know only what I have read, and have been told by those who have visited them.

The words "Cameron tanks," on the table referred to, is objected to as hearsay.

Adjourned to Saturday, July 1st, 1905, 10:30 A. M. 1982

New York, July 1st, 1905, 10:30 A. M.

Met, pursuant to adjournment.

Present, counsel as before.

Re-Cross Examination of Mr. Snow Continued:

R-XQ. 313. What is the reason, as you understand it, that in any septic tank similar to that at 1983
Saratoga there is any solid matter at all that ever has to be removed otherwise than by running off with the effluent? A. There may be a good many reasons, some sewages may not be at all adapted to septic action and in that case the tanks would fill up very rapidly. In other cases, as has been observed in practice, the solids accumulate very rapid- 1984
ly for no known reason. The leading exponents of the art are at loggerheads upon this very question. Success has attended the operation of our plant, possibly by accident, and possibly through the excellence and skill in design and the exercise of good judgment based upon our observation and experi-

ence. As I have hereinbefore stated, at this time in the development in the art, every septic tank may be considered an experimental one.

R-XQ. 314. Does in-organic matter in some cases constitute any part of the solid matter that has to be removed otherwise than by running off with the
1986 effluent? A. Yes, quite a considerable part in some cases.

R-XQ. 315. So that in cases where the composition of the sewage contains a greater per centage of in-organic or mineral matter, the solid matter that has to be removed otherwise than by running off with the effluent, is, all other things being equal,
1987 likely to be greater? A. Yes.

Re-Cross Examination Closed.

Re-Direct Examination:

R-d-Q. 316. What was the title of your address before the Indiana Enginering Society, on January 25, 1889? A. American versus English Progress in Sewage Purification.

1988 R-d-Q. 317. When was this address prepared? A. During the week of January 14th to 21st. 1899.

R-d-Q. 318. How long had you had in your possession the data upon which you based the statements made in this address? A. Some of it I obtained in 1897, and the rest during 1898.

R-d-Q. 319. Are the following excerpts of the
1989 said paper?

"Of late we have heard a great deal about the accelerated processes of sewage purification, particularly with reference to preliminary treatment in the septic tank or bacterial filter.

"Very satisfactory results are claimed for these methods in England, notably at Exeter and Sutton. Familiarity with their writings and discussions leads one to conclude that the English experts are not generally well informed of American progress, and even some American writers have overlooked what has been ascertained at home of the fundamental principles of sewage purification, and the extent to which this knowledge has been applied in actual practice.

. . . .

"Since then we have proved conclusively that 1991
by a separation of the suspended and dissolved organic matters in the tank, through sedimentation, the upper layers of the tank contents—stale sewage—can be applied to the filters and decomposed at very high rates, requiring no raking of the surface or the beds from spring to fall; and that the lower layers of the tank contents called sludge, can be most successfully and economically treated by application in slower rates to particular fil- 1992
ters."

. . . .

"We see, therefore, that the distinction between fresh and stale sewage was made at that time, the changes brought about by putrefactive action were noted, and also the increased tendency of stale sewage to clog the filter.

. . . . 1993

"The economy of staling the sewage and separating the suspended matters and applying the sewage and sludge, as above described, is therefore made apparent.

"That the capacity of a filter depends upon the arrangement of the constituents of the sewage, as well as the amount of these constituents, was known by the State Board of Health and practi- 1994
cally applied at Brockton months before the world knew anything about the Exeter septic tank experiments.

. . . .

"How much stale sewage can be applied in twenty-four hours on an acre at Brockton has never yet been ascertained, principally for the reason that the flow of sewage has not been

1995 F. HERBERT SNOW.

enough to require pumping more than three hours each day.

"Each bed is usually dosed at the rate of 3800 gallons per minute for between twenty and thirty minutes. Because of lack of sewage twenty-four hours elapses before the dose is repeated.

"We have been able to apply 140,000 gallons
1996 of stale sewage in thirty-five minutes to some of the beds, and in four hours every sign pointed to conditions favorable for a second dose. This would be at the rate of 840,000 gallons per acre daily."

A. Yes.

Examination of witness closed.

Adjourned subject to notice.

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UNITED STATES CIRCUIT COURT—NORTHERN DISTRICT OF NEW YORK. 2000

CAMERON SEPTIC TANK COMPANY,
Complainant,
against
VILLAGE OF SARATOGA SPRINGS, AND THE SEWER, WATER AND STREET COMMISSION OF SARATOGA SPRINGS, 2001
Defendants.

In Equity No. 7025.

Testimony on behalf of the defendants for final hearing, taken at the office of Messrs. Banning & Banning, Marquette Building, Chicago Illinois, before Oscar W. Bond, Notary Public. 2002

Chicago, August 2, 1905, 10:00 A. M.

Met by agreement of counsel: Present, Mr. George P. Fisher, Counsel for Complainant; and Mr. Ephraim Banning, Counsel for Defendants.

Arthur N. Talbot, a witness produced and sworn on the part of defendants, deposes and testifies as 2003
follows in answer to questions by Mr. Banning.

Q. Please state your name, age, residence and occupation? A. Arthur N. Talbot, 47 years, Urbana, Illinois. I am professor of municipal and sanitary engineering in the University of Illinois, and a civil engineer.

Q. 2. Please state what experience you have had 2004
as a sanitary engineer, what societies you are a member of, etc. A. I took the course in civil engineering in the University of Illinois, graduating in 1881. The course was four years. From 1881 to 1885 I was engaged in civil engineering work on railway construction, location and maintenance.

Since 1885 I have been connected with the University of Illinois, first as assistant professor of engineering, and since 1890 as professor of municipal and sanitary engineering. Since 1885 I have at various times been engaged in engineering work, including the designing and construction of sewer-
2006 age systems and sewage disposal plants. I have at various times visited sewage disposal plants for the purpose of acquiring information concerning them. I have been a member of the American Society of Civil Engineers since 1888. I am a member of the Western Society of Engineers, the Illinois Society of Engineers and Surveyors, the
2007 American Society of Municipal Improvements, the American Water Works Association, and the American Association for the Advancement of Science.

Q. 3. Please state where you have examined sewage disposal plants or seen them in operation? A. Without attempting to enumerate all that I have
2008 visited I will mention that in the summer of 1892 I spent three weeks in Massachusetts inspecting sewerage construction, sewage disposal plants and water works systems. At that time I visited plants at Marlborough, South Framingham, Worcester, Westboro, and other places, and also made a visit to the experiment station of the Massachusetts
2009 State Board of Health at Lawrence. In 1900, while in England, I inspected a number of sewage disposal plants including the ones at Exeter, Yeovil, Manchester, Leeds, Accrington and Sutton.

Q. 4. Have you had anything to do with the construction of sewage disposal plants at Urbana and Champaign, Illinois? A. Yes.

Q. 5. Please state fully, what you had to do with
the construction of such plants when and how the
same were constructed, how they operated, etc. In
answering this question you may refer to any docu-
ments, papers, or data in your possession. A. In
May, 1894, I was employed by the City of Urbana,
Illinois, to design and have charge of the construc- 2011
tion of a sewerage system for a part of that city.
Included in this work was the problem of the dis-
posal of the sewage in the future. Upon my recom-
mendation the city purchased a tract of land within
the city limits through which a small creek flowed.
My recommendation was the construction of a tank
immediately to be followed as soon as the circum- 2012
stances made it necessary with the construction of
some form of artificial sand filter bed. I designed
this tank, which was then called the settling tank,
or merely the sewer tank, and it was constructed
under my direction in October and November, 1894.
It was connected with the sewer and put into opera-
tion in November of that year. This tank was 22 2013
feet long, four and a half feet wide, and about four
feet deep below the flow line of the sewer. It was
built of brick and was covered with a heavy plank
cover, an inlet chamber contained a gate for shut-
ting off the flow, and another gate was connected
with a by-pass, through which the sewage could be
discharged directly into the stream. At the outlet 2014
end a weir wall extended entirely across the tank,
and the sewage passed through a shallower cham-
ber to the outlet pipe at the end of the tank. A
wall of brick was built across the tank near the mid-
dle and extended down into the tank about 15
inches below the level of the sewage. A baffleboard

was placed across the tank about three feet from the inlet end and extended from above the surface of the water to a point about 12 inches below its level. A similar bafflleboard was placed about three feet from the discharge weir before mentioned. A sludge gate was built into the brick wall near the
2016 middle of the length of the tank and at the bottom, but this was not connected with an outlet, being sealed up. The sketch which I have here is the original plan from which the masonry work was constructed. It was drawn by my assistant, M. S. Ketchum, who is now professor of civil engineering in the University of Colorado, from a preliminary
2017 sketch made by me. It was built substantially as shown, but the inlet chamber was made with a flat bottom. No complete plans were made as the work of construction was done directly under the supervision of my assistant. The cover and baffle boards were put in by the superintendent of streets of Urbana. The dates of construction I have verified by
2018 reference to memoranda made at the time. There is no date on this sketch, but I know of my own knowledge that it is the sketch made at that time. It has ever since been in my possession, and it has not been altered in any way.

The operation of this tank proved quite satisfactory. The effluent was quite clear and no nuisance
2019 was caused in the creek into which it was discharged. The people of Urbana who had been apprehensive of trouble from the discharge of the sewer were pleased with the result.

In June, 1895, I was engaged by the City of Champaign, Illinois, to design a sewerage system. The city of Champaign adjoins the city of Urbana

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on the west, and its natural drainage is down a small stream commonly known as Boneyard Branch, which flows easterly entirely through Urbana and discharges into the creek before mentioned as the outlet of the Urbana sewerage system. To get to this creek and have a gravity flow, it was
necessary for the city of Champaign to secure a 2021
right of way for its outlet sewer through the streets, alleys and other property in the city of Urbana. My first services were to assist in securing an ordinance giving the right of way for this outlet sewer. At this time, in 1895, there existed a tile drain along the Boneyard Branch, in Champaign, which
discharged into that stream within the limits of 2022
Urbana. This tile carried the discharge of many water closets, sinks and cesspools connected with buildings in Champaign. The discharge of this tile during times when the Boneyard Branch would otherwise be entirely dry created a considerable nuisance in the Boneyard Branch in the west part
of Urbana, producing foul odors, and was a source 2023
of annoyance to residents in the neighborhood. This condition had existed for several years, and had been a source of damage suits against the city of Champaign. The city council of Urbana were averse to granting the right of way with the conditions then existing, finally it was agreed that the
city of Champaign should construct in East Side 2024
Park, a small park lying within the limits of Champaign and through which Boneyard Branch passed, a tank similar to the settling tank used with the Urbana sewerage system. The city council were so well satisfied with the operation of the Urbana sewer tank that they felt that the construction of

this tank in Champaign would remedy the condition complained of. A tank was built in East Side Park June 13 to 15, 1895. This tank was about 32 feet long, 7 feet wide and 4 feet below the water level of the tile. It was constructed by making an excavation, lining the sides with two lengths of 16
2026 foot boards and bracing across. The ends were boarded up in a similar way. A screen of wire netting was placed across the lower end, and one or more baffle boards were placed across the tank extending from above the water surface to a depth of about ten inches below the water level. The top was covered with a board cover. The tile drain
2027 before mentioned was connected at the upper ends and at the lower ends so that the flow of this drain would pass through the tank. I do not recall the exact construction at the lower end of the tank, but there was some device for maintaining the level of the water over which the flow passed, and there were no drawings made for this tank, but it was
2028 constructed under my direction by the superintendent of streets of Champaign with city labor. On July 8th, 1895, the city council in the city of Urbana passed the ordinance giving the city of Champaign the right to construct and maintain the sanitary sewer across and through the city of Urbana. I have a printed copy in my hand of the ordinance
2029 passed by the city council of the city of Champaign, July 16, 1895, which embodies the ordinance of the city of Urbana, just referred to, and on which this date of July 8, and approved July 9, appears.

During June and July, 1895, I designed the sanitary sewerage system for the city of Champaign. A tract of ground was chosen just outside and ad-

joining the city of Urbana on the east and through which the small creek before referred to flowed. This property was selected because its topographical features were such as would enable the construction of sewage disposal works, and because it was beyond the limits of the city of Urbana, a condition which was specified by the Urbana council. Includ- 2031
ed in the design of the sewer system were two tanks, then called by me "separating tanks." The ordinance for the Champaign sewerage system was passed August 6, 1895, and approved August 9, 1895. It contains this provision for the separating tanks:

"Section 7. Two separating tanks shall be con- 2032
structed at the lower end of said sewer on the disposal ground. They shall be each eight (8) by forty (40) feet in size, and shall be built to a depth of five (5) feet below the bottom of the grade of the outlet sewer. The walls shall be built of hard burned brick laid in cement mortar and shall be plastered on the inside and outside. The bottoms shall be of concrete or brick masonry. They shall be covered with a substantial cover and shall 2033
be provided with such partitions, screens, gates and effluent pipes as will be necessary for the proper separation of sludge from the sewage, and for the purpose of removing the same."

The construction of the Champaign sewerage system was continued over several years, due to difficulties in making bonds salable and to the failure of contractor after contractor to complete the 2034
work. Although the assessment for the improvement was approved by the court and bids received, and contract awarded for the lines for the sewer system, before the end of November, 1895, and, although the contractor came on the ground ready to begin work, it was finally concluded in March,

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1896, that it would be necessary to wait until the
receipt of the next general tax funds. The contract
was let a second time in August, 1896, and the new
contractor began work. He failed to push the work
vigorously and in November, 1896, gave up the
work entirely. The council advertised again for
2036 bids and the contract was let to a third contractor,
who finally allowed the amount of one thousand
dollars which he had deposited to be forfeited to
the city. The work was then let to a fourth con-
tractor who began the work of sewer building in
June, 1897, and continued until September, when
he failed in the work. The surety company, his
2037 bondsman, then took up the work and let it to a
fifth contractor who began work in November, 1897.
This company finally failed and its bondsman next
took up the construction, subletting it to another
firm. The separating tank at the outlet had not
been included in any of these contracts, and no
work was done upon it because it could not be of
2038 service until at least the outlet sewer was com-
pleted. It was built in August, 1897, under my
direct supervision, and by a force of city laborers.
So far as the tank proper is concerned. The walls,
roof, doors and other features of the superstructure
were put in by local contractors. The outlet sewer
was completed in October, 1897, and was connected
2039 to the separating tank November 1, 1897, by R. P.
Brower, then city engineer of Champaign.

The tank was constructed substantially as described in the sewer ordinance. Most of the tanks walls, however, were, because of ease of construction, built of concrete, and instead of a flat roof at the surface of the ground as was at first con-

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templated, the walls were run up high enough to admit doors and easy passage into the structure, thus forming a building over the tank. The drawing which I have here shows the plan of construction originally contemplated, except that the roof is not shown. A second drawing shows the changes
which were made before construction. In addition 2041
to the change in the side walls and position of the roof, the cross wall at the bottom of the tank was omitted and the building was made longer to provide space for a small steam engine. This first drawing is marked "Separating Tank for Champaign Sewerage System." Another variation in
construction from this plan consisted in making the 2042
bottom face of the cross wall at the middle of the tank horizontal instead of arched. The second drawing is marked "Separating Tank Champaign Sewerage System."

The dates in the foregoing statements of the Urbana Sewerage System and the Champaign Sewer-
age System are taken from memorandum diaries of 2043
the progress of the work under my charge which I here have, the entries all being made at the time.

The University of Illinois is located between the cities of Champaign and Urbana and within the corporate limits of the latter. The growth of the university and the need for further improvement
made the university authorities desircus of having 2044
sewer systems constructed in the two towns. As one of the difficulties in the way lay in the fact that the outlet of the sewerage system must be a small creek, I had given some thought to a treatment of the problem which would come within the means of the cities as they would be likely to make

the expenditure. As the stream was not used as a source of water supply it did not seem necessary to provide the complete treatment which was advocated in some parts of the country, and I felt that if something could be done which would partially purify the sewage and which could at a later date
2046 be extended as necessary, and even connected with a set of filter beds or other method of final purification, this would meet the requirements of the situation. In July, 1892, I saw work on the construction of a sewage disposal plant for Wellesley Collage, Wellesley, Massachusetts, and was told by Captain Henderson, the engineer in charge of the
2047 construction, that their plans for the construction of a settling tank were suggested by Mr. Noyes, then city engineer of Newton, Masachusetts, who, according to my memorandum, made at the time to which I now refer, "is authority (H. says) for the statement that at a school house in Newton where top was sealed no deposition of sludge occurred—
2048 all matter being gradually reduced to fine enough composition to be carried off into the under drain."

I went to Newton soon after, but Mr. Noyes was away from town. I afterward wrote to him asking for particulars of the installation referred to by Captain Henderson, and received the following letter which I here produce, in an envelope which I
2049 hereby identify, and which is postmarked "West Newton, Mass., Mar. 18, 1893," viz.:

 2050

"Subject

In reply to your favor of

Albert F. Noyes,
City Engineer,
City of Newton, Office of City Engineer.
City Hall, West Newton, Mass., March 18, 1893.
Arthur N. Talbot, Esq,
Champlaign, Ill. 2051
Dear Sir:—

Your favor of the 10th inst. was duly received, as was also one of some months ago, inquiring in regard to a covered sewerage receiving tank, which was described to you by Capt. Henderson.

I would say that I laid your first letter one side, in order to look up information which would make the facts more clear, and like everything that is put off from day to day, it is not done. 2052
Now I will attempt to extend to you the information which you desired.

I would state that in 1882 there appeared in the Engineering News, in Volume 9 under date of April 15, 1882, a description of the Automatic Vault Cleaner, and a design by one, M. Mouras, a copy of which I send you, thinking that possibly you may not have the volume referred to.

At that time we were designing for the drain- 2053
age of a dwelling for the Engineer and Fireman at the Pumping Station, which had to be taken care of by sub-surface irrigation, and thought it a good chance to apply the plan to the drainage of the house.

The construction of the tanks were already contracted for, and not wishing to change the plans so as to make an extra charge, I used the original small settling tank, as you will see by the 2054
blue print which I send you, as a receiver, and while it showed that undoubtedly the merits claimed by M. Mouras were correct, the receiving chamber was not large enough to provide liquid enough for taking care of the grease from the kitchen waste from the two families, which in this case was excessive. We opened it over five years ago, and found a considerable depth of

grease, but no other solid, and the grease was not especially rancid.

We were designing at the same time to take care of the drainage from two school houses, and a hose house, an average of about 250 persons. In this case there was no kitchen waste. This was put in, in 1882, and about 1889 was opened and
2056 found to be as claimed by the writer. It has not since been opened.

The distributing pipe system has worked perfectly satisfactory and there has been no trouble from filling up except in a very few points, say one or two feet at the extreme ends, we found a mould which appeared to be more of a deposit from the common angle worm, and to which I assume from appearences it was due.

2057 I have not had a chance to give it a real good test or any drainage system, but assume that to work satisfactorily the sewerage ought to be delivered into the tank fresh.

It will give me pleasure to extend to you any further information which I can, and which you may desire.

Very truly yours,
ALBERT F. NOYES, City Engineer.

2058 I looked up these references and also examined drawings and descriptions of various tanks in connection with the different sewerage systems, including those at *Medfield*, Massachusetts, and *Lawrenceville*, New Jersey. I finally concluded when making plans for the Urbana sewerage system that a tank of the kind built for that town
2059 and previously described would be quite effective, and that it would serve the purpose and make sufficient purification until the quantity of sewage and the extension of the sewer system would make other construction necessary. The tank was arranged so that a second tank could be built on the west side of it without interfering with the op-

eration of this one. It was at first expected that this tank might require frequent cleaning, as was done in some places. After the Urbana tank had been in operation for some months it was concluded best to clean it. A small tank placed on a wagon had been provided, together with an or-
dinary sewer diaphram pump. The street super- 2061
intendent of Urbana, Charles Sell, was instructed to pump out the tank. Contrary to his expectation he found that the job was not a serious or unpleasant one. The tank was easily pumped out, and the contents were discharged on the surface of the ground adjoining the tank. The liquid
portion soon seeped into the ground, leaving only 2062
a thin coating of black earth-like material which had little odor. I should have said that upon opening this tank it was found that there was a scum over the surface and that the lower portion of the tank contained a thin liquid-like thin mud. It was also seen that there was gas aris-
ing, but the tank was free from obnoxious smells 2063
such as are found where offensive putrification goes on. The matter taken out of the bottom of the tank resembled the description given in Mr. Noyes' letter. It was evident, both from the appearance of the tank and from calculations made on the amount of solids which must have passed
into the tank, that there was some change going 2064
on in the tank. I may add that at this time, the spring of 1895, gaugings made on this sewer by students in my classes, showed a daily flow of from ten thousand to twenty-five thousand U. S. gallons per twenty-four hours. I hoped to make

a study of the full operation of the tank, but the
large amount of engineering work which I then
had on my hands in connection with my duties
with the university, both in the class room and
outside, made it impractical to do this. I had
even talked about the action of the tank with Dr.
2066 T. J. Burrill, Vice-President of the University of
Illinois and Professor of Botany, and we went
out to the tank to make an examination. We
found, however, that the earth had washed down
from the side hill or bank as to cover the entire
tank, so as to make it inaccessible without dig-
ging the earth away, and as it was expected then
2067 that the Champaign tank would be constructed
soon, it was thought best to wait for the comple-
tion of that tank, as the arrangements for it would
make it quite easy of access. As before stated,
sewage was turned into the Champaign separat-
ing tank November 1, 1897, and on November 6,
according to my memorandum here, I took Dr.
2068 Burrill to the Champaign separating tank for an
investigation. He took samples from the tank.
He had said that with the action going on in the
tank the gas evolved must be inflamable, and so
we stirred up the bottom of the tank and lighted
it with burning paper, and found that it burned
readily. Later Dr. A. W. Palmer, professor of
2069 chemistry, collected a sample of the gas and made
an analysis of it.

In designing the tank for the Urbana sewerage system I had in mind a steady slow movement of the sewage through the tank, and arrangements for making the flow into the tank as smooth and

 2070

free from agitation as necessary, and to have the outlet so disposed that the flow over the weir would be even and distributed over the whole width of the tank. This arrangement was to make little variation in the level of the sewage in the tank and to get the flow distributed as far as pos-
sible over the cross section of the tank. The baf- 2071
fle boards aided in this and also held back floating solids. I had in mind the protection of the tank from light and air as it seemed to me that the settling tanks which were exposed to light and air had given off offensive gases. I knew that this slow velocity through the tank would
hold back solids in suspension by subsidence, but 2072
I did not know how large the tank should be for any given quantity of sewage.

In the design of the tank at the outlet of the Champaign sewerage system I had in mind the same condition. This tank was provided at the inlet with an enlarged or flaring mouth, flaring
sidewise and downward at the same time. Be- 2073
sides the inlet sewer pipe was dropped below the regular grade of the sewer so that for a small depth of sewage in the sewer the sewer pipe at the inlet would be filled to a greater depth, and thus make the area cross section of flow at this point greater than back in the main sewer, and
thus reduce the velocity of flow into the inlet of 2074
the tank, thereby providing freedom from disturbance and agitation and distributing the flow better over the cross section of the tank. The weir at the outlet end of the tank was made with an angle iron to better distribute the flow over the entire width of the tank and to allow more

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complete agitation as the water went out of the tank. Of course the construction of the building over the tank gave better facilities for access and for such cleaning of the tank as might be found necessary.

2076 Counsel for complainant offers in evidence the following drawings and papers referred to by the witness in his foregoing answer, viz.:

1. The sketch stated to have been drawn by Mr. M. S. Ketcham, showing the design of the first tank constructed
2077 at Urbana; and the same is marked "Defendants' Exhibit Urbana Tank November, 1894."

2. The drawing of the second Champaign tank, having on it the words "Separating Tank for Champaign Sewerage System," and the same is marked "De-
2078 fendants' Exhibit Champaign Tank, Drawing No. 1."

3. The drawing of the second Champaign tank having on it the words "Separating Tank Champaign Sewerage System A. N. Talbot M. Am. Soc. C. E.;" and the same is marked "Defendants'
2079 Exhibit Champaign Tank, Drawing No. 2."

4. Letter from Albert F. Noyes, City Engineer, City of Newton, Massachusetts, dated March 18, 1893, as quoted by the witness in his foregoing answer.

 2080

5. Ordinance of the City of Champaign, Passed and Approved July 16, 1895, embodying ordinance of the City of Urbana, Passed July 8 and Approved July 9, 1895; and the same is marked "Defendants' Exhibit Ordinance No. 1."

2081
6. Ordinance of the City of Champaign, Passed August 6, 1895, and Approved August 9, 1895, and the same is marked "Defendants' Exhibit Ordinance No. 2."

Complainant's counsel objects to such parts of
the foregoing answer of the witness as relate to 2082
constructions and modes of operation that he has asserted to have had in mind and which do not appear to have been embodied in practical form. Counsel also objects to the answer and to the exhibit concerning the Urbana tank as not being the best evidence, it not appearing that such tank
is not at present in existence and capable of be- 2083
ing illustrated by a drawing made in strict accordance therewith. Counsel for complainant objects to the testimony of the witness respecting the first Champaign tank, as it is not the best evidence with respect thereto, it not having been shown that no drawings were made from such
tank, or that said tank is no longer in existence. 2084
Counsel for complainant also objects to the exhibits illustrating the second Champaign tank and the testimony concerning said exhibit drawing as it has not been made to appear that said drawings are the best evidence or best reproductions obtainable of said tank.

Complainant's counsel waives the absence of
certification upon the exhibits of ordinances in-
troduced in evidence.

Q. 6. Please state more specifically what you
know about the three drawings referred to in your
last answer and now offered in evidence as "De-
2086 fendants' Exhibit Urbana Tank, November,
1894;" "Defendants' Exhibit Champaign Tank,
Drawing No. 1;" and "Defendants' Exhibit
Champaign Tank, Drawing No. 2," particularly
as to time when the same were made, and as to
how far they correctly represent the constructions
with which you connect them, respectively? A.
2087 The drawing marked "Defendants' Exhibit Ur-
bana Tank, November, 1894," is as stated in my
answer to the previous question the original plan
from which the masonry work was constructed.
It was drawn in October, 1894, from a preliminary
sketch made by me, and further directions con-
cerning the design. The preliminary sketch is
2088 here submitted. The inlet chamber was made
with a flat bottom and without the curved invert
shown in the sketch, "Defendants' Exhibit Ur-
bana Tank, November, 1894." The cross wall at
the top of the tank is shown in the elevation on
this drawing, but not in the plan, and the notches
shown in plan at the middle of the tank were
2089 omitted. This cross wall was put in instead of
the baffle boards first planned for the middle of
the tank, in order to stiffen the side wall. The
inlet gate and the timber work constituting the
cover of the tank is not shown on this drawing,
nor are the baffle boards heretofore described, nor
the outlet pipe to which it was connected with

 2090

the tank. This drawing shows the masonry work of the tank. As before stated, the baffles and the roof were put in by the superintendent of streets of Urbana. The preliminary sketch was not used during construction, but was for the purpose of explaining to the draftsman the features 2091
of the design as I wanted them. It merely happens to be among some of my old papers.

The Exhibit marked "Defendants' Exhibit Champaign Tank, Drawing No. 1," I am not able to give the exact date of. It was drawn during the first half of 1896. This is not the drawing from which the tank was finally built, but is re- 2092
ferred to as showing the progressive steps of the work. The roof is not shown on this drawing.

The Exhibit marked "Defendants' Exhibit Champaign Tank, Drawing No. 2," was drawn in December, 1897, or in the early part of the year 1898. It shows the tank as it was constructed. These two drawings were made by Ralph P. 2093
Brower, the first named one, before he became City Engineer, and the latter one while he was City Engineer of the City of Champaign.

Counsel for defendants offers in evidence the preliminary sketch referred to by the witness in his foregoing answer, and the same is marked "Defendants' 2094
Exhibit, Professor Talbot's Preliminary Sketch."

Adjourned until Thursday, August 3, 1905, at 10 o'clock A. M.

Thursday, August 3, 1905, met pursuant to adjournment; present as before.

2095 ARTHUR N. TALBOT.

Q. 7. Please state how long the several plants at Urbana and Champaign referred to in your foregoing answers were used, and how extensively and particularly how they were used with reference to each other—that is, whether they were the same in operation or different; what their ac-
2096 tion was with reference to sewage; whether they are still in existence, etc. A. The tank at Urbana was put in opration in November, 1894. When it was opened to be cleaned in the spring of 1895 there was found to be a coating of scum on the top and a deposition of matter in the bottom, which I have always called sludge. This sludge
2097 was materially different from the floating organic matter of sewage. When this sludge, which was of a thin consistency, was pumped out and deposited on the surface of the ground it was found to be comparatively free from odor. In fact, the absence of what I have always called putrefactive action, using that word as I had been
2098 taught to use it, to mean offensive decomposition, was a marked feature of the condition of the plant. Instead of finding a stinking cesspool, the tank was comparatively free from offensive odors. The effluent was quite clear and free from floating solids. This was what we were trying to secure. Our purpose was to get a clear effluent
2099 and one that would not cause a nuisance in the stream below. The discharge of this effluent into the stream caused no noticeable effect along the banks or in the neighborhood. While I could see that there was some kind of action going on in the tank which included the formation of gas, my study and work with sewerage and water supply

 2100

engineering had been with the constructive and hydraulic side, rather than with the chemical and biological side. At that time I had given little attention to bacteriology, and I was not particularly interested in that side of the question, and my attention was therefore given to the appearance of the effluent and the general condition of 2101
the tank. We found that we were getting rid of the solids in suspension and my estimates of the amount of suspended matter carried by the sewage made at that time showed me that the amount of solid matter in the sludge was considerably less than the amount of solid matter carried in the sewage; and this was the first element of the prob- 2102
lem for towns situated like Urbana and Champaign, and was of considerable interest to me. During the spring of 1895 and up to the time the ordinance for the Champaign sewerage system was written the flow of sewage in the Urbana outlet sewer amounted to from ten thousand to twenty thousand U. S. gallons per 24 hours as 2103
shown by gaugings made by my students during this time. This was in the spring and early summer of 1895. At that time there were about four miles of sewer connected with the outlet sewer, but most of the sewage came from the buildings of the University of Illinois, as there were but few connections made at that time from houses out- 2104
side. The line of sewer from the university to the outlet was about two miles in length, and was laid on a very flat grade, a part on a grade of one in nine hundred and the remainder of one in eleven hundred. This low grade, together with the small flow in the sewer, resulted in a low ve-

locity and the sewage required considerable time to reach the outlet after it left the buildings. The tank remained in operation, so far as I knew, until recently. I am informed that it was disconnected from the sewer in July, 1905. I visited this location August 1, 1905, and found that the
2106 walls had been broken down, gates removed, cover broken, and other changes made showing a general delapidated condition. As the university grew in numbers, and as the city of Urbana grew and the sewerage system was extended, and more fully used, the amount of sewage passing through the tank and the quantities of solids
2107 passing into it became so great that while the same kind of an action went on in the tank as before, the tank became less and less efficient. For the first three or four years of its operation I examined it occasionally and was able to see that the quantity of sewage passing through it was becoming too great for its size. The retained
2108 solids were not reduced in the same way and the odors arising from the tank were noticeably different and markedly stronger. The suspended solids were carried through the tank for a much larger extent, and the tank itself became so filled with solids that the material coming from the sewer was carried on through the outlet.

2109 The operation of the tank was not under my charge. The superintendent of streets cleaned it two or three times a year during the years '95 and '96, when I had knowledge of it. I do not know definitely of the method of handling it since 1896. The tank was known to the public and was visited by members of the city council of

 2110

Urbana, and of the city council of Champaign, by students of the university, and other people. Any one could see it who desired to.

The tank before mentioned as the first Champaign tank was put in operation in June, 1895, and continued to discharge into the same tile outlet until the Champaign outlet sewer and the sec- 2111
ond Champaign tank were put in operation, November 1, 1897, when its outlet was connected with the Champaign sanitary outlet sewer, and its discharge also passed through the second tank. It was disconnected from the sewer system upon the final completion of the Champaign sanitary sewer system some time in 1898 or 1899. By this 2112
time the houses formerly discharging into it had been connected with the new system of sewerage and the object of its use had passed. I am informed that the whole was filled in two or three years ago when improvements were made in the park.

So far as its operation is concerned, I can only 2113
say that the sludge which I saw on the ground when the tank was cleaned out resembled that taken from the Urbana tank, and that the general condition was similar. The conditions along the bank of Boneyard Branch below the point where the tile outlet discharged were improved, and the residents were pleased with the change made. 2114
There were other tiles having house connections of a similar nature which discharged into the outlet tile below East Side Park, and hence the situation along Boneyard Branch was not entirely good. The tank was in a public park and its construction and use were known of by the public.

2115

The second Champaign tank was put in use
November 1, 1897. I visited it November 3, 1897,
and have a memorandum to the effect that it was
operating very successfully, and that the effluent
was good and the floating sludge was forming.
On November 6, 1897, as previously stated, Dr.
2116 Burrill took samples from the tank and the tank
was stirred up and gas ignited. The action of
the tank, as I found by inspections afterwards,
was quite similar to what I had observed in the
Urbana tank. A floating sludge or scum formed
on top and a heavier sludge formed at the bottom,
and the effluent was clear and quite free from
2117 solids in suspension. As the construction of the
building was such that there was easy access inspection
of its operation was much more easy
than was the case with the Urbana tank, and I
took the opportunity at different times to get
samples of the effluent and of the sludge at the
bottom and at the top. Provision had been made
2118 for a pump to clean the tank whenever it became
necessary.

It was first cleaned out in 1898, about six months
after it was put into operation, and during the following
year it was cleaned out about three times.
It was my thought then that frequent cleaning was
advantageous, and it probably did not need cleaning
2119 so often. This tank was visited by many people
and its efficiency greatly surprised them. The
Champaign sewerage system was not entirely completed
until 1899, and from January, 1898, to the
present time there has been a large increase in the
population of the city, and in the number of connections
made from houses to sewers, and the sys-

tem has been extended to other parts of the town. The tank continues to operate. With the increased amount of sewage and the much larger quantity of organic solids reaching the tank the capacity of the tank has been exceeded for efficient work and while the same activity goes on in the tank, yet its size
is not sufficient to reduce the organic solids in sus- 2121
pension to the same extent that it did at the beginning. At the time this tank was put in operation the flow of sewage at the time when large amounts of ground water were not reaching the sewer was less than one hundred thousand U. S. gallons per day. With the growth of the sewer system and con-
nection this flow increased until there is now four 2122
hundred thousand or five hundred thousand gallons per day passing through the sewer. In addition to this there have been at times considerable quantities of ground water reaching the sewer.

I do not know the present flow through the Urbana outlet sewer, but I judge it must be at least
two hundred thousand gallons per day. 2123

The cubic capacity of the Urbana tank below the ordinary level of the water in the tank was about two thousand eight hundred gallons. The cubic capacity of the first Champaign tank below the level of flow through the tank was in the neighborhood of six thousand eight hundred gallons. The cubic
capacity of the second Champaign tank below the 2124
level of flow through the tank was about twenty-two thousand gallons. This refers to the combined capacity of the two tanks which I have heretofore spoken of as the second Champaign tauk. The general principles of the design of these tanks so far as form, shape of inlet and outlet and general position of the parts is the same as I have since used in the design of tanks for the same purpose. I do

2125 not know exactly what the amount of the discharge of sewage through the first Champaign tank was, but, according to the best of my recollection, it was during the dry period of the year less than fifty thousand gallons per day, and part of this was ground water.

2126 Q. 8. What effect does too great a flow of sewage through a tank of the kind you have been describing have with reference to solids in suspension with reference to the effluent, etc. A. In the operation of such tank by reason of differences in specific gravity under the conditions of slow and regular flow through the tank, solids in suspension in the
2127 sewage rise or fall and are retained, while the liquid portion of the sewage passes on through the tank. This retained solid matter is both inorganic and organic. The inorganic matter in general of course is not modified. Under the conditions of darkness or absence of sunlight of ill ventilation or absence of aeration and the presence of moderate
2128 heat the biolytic activity of the class of organisms known as bacteria reduces or decomposes the retained organic matter, the process being combined with chemical decomposition going on under these conditions. The time required for the reduction of this retained organic matter does not depend upon the time taken for the liquid portion of the sewage
2129 to pass through the tank. The time required for this reduction and the resulting size of the tank depend upon many conditions, and among these are the character of the sewage including its strength, amount of solids in suspension, amount of or freedom from manufacturing wastes, time elapsing between the point of discharge into the sewer

and the tank, and changes going on during this period. The biolytic activity is different at different depths in the tank, the greater amount being in the zones near the top and bottom of the tank. The horizontal area of these zones, therefore, has a bearing upon the ability of the tank to reduce
larger or smaller amounts of organic matter. The 2131
velocity through the tank must be slow enough, not only to permit the subsidence of matters in suspension, but also not to interfere with the biolytic activity by disturbing the growth of the organisms. When the floating solids are carried into the tank in such large quantities that they fill up the zone
of activity so completely as not to permit the organic 2132
matter which has previously been retained but not yet completely acted upon by the organisms, the tank becomes less efficient, and with a still greater flow of sewage the action is further reduced until the tank becomes merely a receiving tank for the solids, and after the space has been filled the in-
coming sewage carries its suspended solids through 2133
the tank with considerably less amount of reduction in suspended solids. Under these conditions the tank becomes ineffective and while there is some biolytic action going on, the conditions are not favorable for the purification of the sewage. What the cubic capacity of the tank must be in terms of
the daily flow of sewage is a complex question in- 2134
volving the matter of the composition of the sewage just spoken of, and of many conditions of temperature, shape of tank, etc., and is yet a disputed question among engineers. It is the case, however, that when the quantity of sewage passing into a given tank becomes too great the organic solids are not

reduced to the same extent, the tank soon fills up, the suspended solids are carried on through the tank, the effluent does not differ particularly from the incoming sewage, and the conditions in any small stream into which the tank discharges would show the changed condition. The retained solids
2136 would be subject to another form of change and the conditions would resemble what I have heretofore termed the putrefying condition and offensive odors would be produced and the contents of the tank would be difficult to remove and dispose of.

Q. 9. If you have ever written or published anything with reference to the tanks at Urbana and
2137 Champaign which you have been describing, or similar tanks, please explain the same, stating when and where they were written or published, making such references thereto and quotations therefrom as you consider proper, defining the meaning of technical terms used therein, etc. A. At the twelfth annual meeting of the Illinois Society of Engineers
2138 and Surveyors, held at Springfield, Illinois, January 27, 28 and 29, 1897, I gave a paper entitled "The Sedimentation Process in Sewage Disposal." This paper was printed in the twelfth annual report of the society. After stating that conditions in the smaller inland cities of Illinois were different from the surroundings of those of New England and
2139 New York, I went on as follows:

"The method of purifying sewage to be recommended in any case is a matter so dependent upon local conditions that no general recommendation can be stated. Chemical treatment, intermittent downward filtration, broad irrigation, are all efficient methods. Without intending to replace any of these thorough methods, the writer wishes to suggest the claims of an old method—sedimentation or subsidence—for use in small towns where a partial seapraoitn of the impurities is permissable for the present at least, and when an inexpensive method is essential, and also as a preliminary process when it is desired to get a higher working capacity for filter beds and other purification plants.

By sedimentation process is here meant a sep- 2141
aration of the lighter and heavier solid matters in suspension in the sewage by the action of gravity as the sewage flows through a tank built in such a way that the current of sewage will be distributed over a considerable area of cross-section across the middle of the depth of the tank, and hence will be so reduced in velocity that the lighter and heavier solids will be left behind in the tank. This action is independent of screens or
filters, and is made without the use of chemicals. 2142

* * * * * * *

These floating putrescible wastes are liable to cause a nuisance when discharged into a small stream, and may make such a disposal very objectionable. It is for the purpose of avoiding this nuisance that this process is suggested.

The separating or subsidence tank should be at
least five times the width of the sewer, and the 2143
depth should be at least five feet below the discharging line. The sewer should be widened out at the inlet and the invert dropped in such a way that the current of sewage will be distributed over the full width of the tank on an area below the surface of the liquid. If this is properly done the velocity will be reduced to one-twentieth or even to one-fiftieth the velocity in the sewer. This
will permit subsidence to take place. 2144

To prevent the floating matter flowing out, tight partitions are built across the tank at intervals, reaching from the top down to a depth of 1.5 to 2 feet below the surface of the water. The current of water passes under these partitions, distributed over the width of the tank and over a greater or less depth. The first matter to float is held in front of the first partition, that separat-

2145 ing later is held by the next, and so on as the tank is filled up. These partitions prevent surface currents as well as retain suspended sludge. At the same time the solids, which are somewhat heavier than water, settle to the bottom. A partition may be built across the bottom of the tank, but as such a construction would tend to concentrate the flow and increase the current above the
2146 partition, and as the absence of this obstruction will give a greater cross-section of flow and permit a slower and more uniform current.

Near the lower end of the tank is placed a weir or wall across the tank at about the level it is expected that the water in the sewer will generally flow. As the water will flow but an inch or two over this if properly placed, the height of water in the tank is always nearly the same, and
2147 this arrangement will keep the current distributed across the tank and require the effluent to rise before going over the weir. Beyond this weir the effluent is collected and is discharged through an outlet pipe. Unless there is to be an attendant around the tank no screens should be put in, as clogging at one part of the tank will concentrate the flow at some other point and defeat the principle on which the tank operates. Of course there
2148 are conditions where peculiar manufacturing wastes will require both screening and coarse filtration. When the tank becomes overcharged with sludge the flow will be contracted and the current will carry solid matter through.

The sludge retained in black, semi-liquid, somewhat matty on top, but mostly finely divided and easily mixed with more water. Where the tanks are kept tightly covered and away from the light,
2149 and the sludge is taken out before the tanks are too full, there is no noticeable odor, and even while cleaning the odor is not offensive; while the tanks which the writer has been told were considered to be offensive were ventilated and exposed to the light. Without attempting to explain the change which goes on in the tank, it may be said that the freedom from putrefaction and the absence from stench is largely due to

darkness. Such tanks should always be tightly
covered and all light excluded.

The sludge may be discharged on waste land
and plowed under, or it may be used as a fertilizer.
At Urbana it is pumped into a wooden
tank on a wagon by means of a common diaphram
sewer trench pump with a three-inch suction, and
then the tank is allowed to empty on waste land, 2151
the water soon disappearing and the thin layer
of black material remaining, not even being
plowed under. In the one to be built for Champaign
a centrifugal pump and small steam engine
is to be used for pumping. Sometimes the location
permits the draining of the tank by gravity
upon a prepared sludge filter bed, and the
dried sludge is carted away by farmers. It may
be deposited in trenches in poor soil and lightly
covered with earth. If the tank is properly cared 2152
for, no nuisance should result.

The plans of the tanks are simple. Oberlin,
Ohio, has a somewhat primitive arrangement
formed by digging a hole in the ground and covering
it with boards—an inexpensive but efficient
tank. At Urbana, Ill., a town of 4,000, a tank
designed by the writer has been in use for over
two years with good results, though it is somewhat
small. This tank is five feet wide, twenty 2153
feet long, and three feet deep below the grade of
invert of sewer. A double tank to be built for
the Champaign sewerage system is shown in the
figure. Each tank is eight feet wide, forty feet
long, and five feet below the grade of invert of
sewer. As stated before, the sludge will be
pumped out by means of a centrifugal pump. The
walls will be made high enough to admit a man 2154
under the roof, not shown on the plan. Manholes,
valves and partitions will be as shown on
the plans. The long weir dam near the lower
end of the tank will cause the level of water in
the tank to vary but a few inches with fluctuations
in amount of sewage. The dropping of the
inlet pipe and the widening and deepening of the
inlet to the tank will slow up the current of sewage
even before it reaches the broad channel of

the tank. It is expected that these tanks will be able to separate sludge from at least five hundred thousand gallons of sewage per 24 hours. With more than that their office would be principally preliminary to some other process.

It is difficult to state the amount of sludge obtained, as there is such a variety in its composi-
2156 tion. At Oberlin, where a man is regularly employed to take care of a sewage farm, it has been found easier to clean the tank once a week since the dilute sludge was easier to pump. This dilute sludge there amounts to five gallons per one thousand gallons of sewage flowing through the tank, and is probably ninety-seven per cent water. At Urbana the sludge is heavier, and is perhaps one or two gallons per 1,000 of sewage—
2157 more than ninety per cent. water. This tank is cleaned four or five times a year, and oftener in dry weather, when the creek into which the effluent discharge is low. It should be cleaned once a month to keep the tank in good condition. The city pays five dollars for having it cleaned.

Of course the effluent is not pure water. The organic matters in solution have not been changed, and more or less of the decomposable suspended matter escapes with the effluent. Tests
2158 show that thirty per cent. and sometimes sixty per cent. of the suspended organic matter is caught, and the albuminoid ammonia gives about the same record; this is surely a great gain. The effluent may be admitted to many streams where the crude sewage would create a nuisance.

But this method has a broader application: That of the preliminary process preparatory to
2159 a more thorough purification of the sewage. In the two towns cited, land has been purchased where purification works may be built in the future when necessary. It is known that the matters in suspension are injurious to filter plants, accumulating near the surface and tending to clog the filter. It is also true that sewage with the suspended matter taken off may be filtered through the sand beds more rapidly than the crude sewage and not injure the filter. Where a

 2160

perfect effluent is not required, rapid filtration through coarse sand of sewage so treated, may be made on a small area, at an expense much less than without this process of separation. It is hoped that an experimental investigation of this subject along the lines of the needs and conditions of the towns of this state may be made, and it is suggested as a fruitful theme for the proposed
Sanitary Engineering Department of the State 2161
Board of Health."

In the foregoing paper it will be seen that the name "Sedimentation Process" and "Sedimentation Tank" is used in place of the term "Separating Tank" which was given to the Champaign tank at the time of its design. There seemed to be no good
name for the tank and this was an effort to get a 2162
better term. The word "putrescible" and "putrefaction" as used in this article had the meaning common in my usage of offensive decomposition and product. The estimated capacity of the tank, that is the amount of sewage which the tank would take care of, was based upon a limited experience, and
I later found that the view was too optomistic. The 2163
word "sludge" is used to indicate the matter which was pumped out of the tank regardless of its condition. I was afterwards informed that the tank at Urbana had not been cleaned as often as I then supposed. The conditions at Oberlin were described to me by the engineer of that place and may not be
accurate. I do not now recall how the estimate of 2164
the per cent of purification at these tanks was made, and I do not now remember that chemical tests were made by the department of chemistry or anyone else of the sewage of the Urbana tank.

At the thirteenth annual meeting of the Illinois Society of Engineers and Surveyors, held at Peoria,

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Illinois, January 26, 27 and 28, 1898, I gave a discussion in connection with the paper of John W. Alvord, on the Purification of Sewage by the Ferozone Polerite System, and I take the following from the report of my remarks given in the Thirteenth Annual Report of the Society:

2166 * * * * * * *

"However, I am particularly interested in the
part of the paper referring to the filtration of the
sewage, because it strikes me that filtration
through polerite may be application to the comple-
tion of purification begun by other means, as, for
example, by the septic or sedimentation process.
Those who were at the meeting last year, may re-
member that I gave a paper upon the sedimenta-
2167 tion process as it is operated in Urbana and Cham-
paign. Since that time there has been published
in the technical journals' descriptions of what is
termed 'The Septic Process of Sewage Treatment,
Exeter, England,' which in many ways resembles
the process there described. This septic process
is, as it might be called, a chemical process with-
out chemicals; at any rate a natural chemical
process which takes place largely through bac-
2168 terial action. The septic tank is air-tight and
light-tight. The sewage is attacked by bacteria
of a different character from those which perform
the action of nitrification in the intermittent fil-
tration process, known as the anerobic, living
without oxygen from the air, and shut in out of
the light of the sun. The effluent is then filtered.
This process has proved to be very successful in
England, and is now engaging the attention of
2169 many scientific men there. The process certainly
accomplishes a great deal; it easily breaks up and
takes out quite a large proportion of the organic
matter in suspension and a part, too, of that in
solution and breaks up the organic compounds.
It would seem that the effluent is much more read-
ily filtered and the filters have a capacity many
times what would be possible if no such process
were used as a preliminary process.

Last year I made the remark that it was my belief that these septic tanks, which I called sedimentation tanks, had a further action than that of mere mechanical sedimentation; that there was an actual organic change going on there, a fermentation, due to the action of the bacteria."

Then follows a general description of the Champaign tank and of the action in the tank, together 2171
with an analysis of gas given off by the tank. The report continues:

As to the conditions which are necessary to get the proper action by this process, it may be said that the sewage should not be too cold. I believe, ordinarily, the sewage in this tank does not get much below 50° F., while 70° would be a more fa- 2172
vorable condition for the growth of the bacteria. The time element, too, should enter into consideration. A sufficient length of time, first, the placing of this tank a long distance away from where the sewage first enters the sewer; and second, a capacity of tank sufficient for the work. In all probability the sewage is, during its flow through a long line of sewer, getting ready for this action, perhaps this action is going on during its course, 2173
especially when there is a very slow current. This tank has not the capacity of the tank in use in England, but it is quite probable that the effect does not depend entirely upon the size of the tank. The holding of the suspended matter in the tank indefinitely after the water passes on through, if there is little current, will permit the chemical changes to be completed.

As to what is left in this tank the statement is 2174
made that at Exeter there is very little permanent material deposited at the bottom. There is always more or less floating material at the top which is finally acted upon and the ash is carried away by the effluent. So far, the tank in the Champaign system has not been cleaned, although there is a slight deposit of rather fine black material in the bottom, and a light coating at the

top. How fast this will increase remains to be
seen.

*   *   *   *   *   *   *

I am glad to be able to make so favorable a re-
port at this time of the action of this system, and
hope by the time of the next meeting there will
be more data upon it. It has seemed to me since
2176 I put in the time at Urbana that this method of
treatment would prove applicable to many west-
ern cities, both as a rough method for taking out
those matters from the sewage which are particu-
larly objectionable in discharging into our small
streams and dry runs until such time as complete
purification is necessary. And a preliminary pro-
cess to filtration permitting a rate of filtration
many times as rapid as would be allowable with-
out it. In the latter case, a small area of sand
2177 and coke, or polerite or some other material not
too expensive, would give a process applicable to
many western towns."

The date of this meeting is the January after the
November 1 when the second Champaign tank was
put into operation of that tank. It was also a
short time after my first opportunity to get infor-
mation concerning the septic tank at Exeter, Eng-
2178 land. The publication in the Engineering News,
January 13, 1898, interested me very much. The
items of an absolutely air-tight and light-proof tank,
and the complete destruction of all solids in sus-
pension impressed me, and I felt that the process
there described must have something different even
from the action going on in the tanks at Urbana
2179 and Champaign, since in these cases there was op-
portunity for gases to escape and there had been
accumulations of sludge. I could see, however,
that the action of the tank at Exeter was similar in
many respects, but with the meager information
then available I was not able to make a very good
comparison. The term "septic tank" which had

been used in connection with the Exeter tank in this publication in the Engineering News was taken up by me as better naming the tanks which I had called separating tanks and sedimentation tanks.

Other articles descriptive of the tank of the Champaign sewerage system will be found in the Engineering News of August 17, 1899, and in the 2181
proceedings of the Illinois Society of Engineers and Surveyors at its Fourteenth Annual Meeting held January 25, 26, 27, 1899.

Decmber 5, 1900, I presented a paper on "Recent Progress in Sewage Purification" before the Western Society of Engineers which was printed in the journal of the Western Society of Engineers for 2182
December, 1900. I quote from the part on the septic tank:

"A septic tank may be said to be a large tank, covered so as to exclude light and air, wholly or substantially, or if open, arranged so that the floating mat which forms on the surface will accomplish the same object, through which the sewage flows, in such a way that it has a very regu- 2183
lar current and a velocity so slow that the matters in suspension in the sewage rise or fall, by reason of difference in specific gravity, and are retained in the tank, where the organic matter will be decomposed, while the effluent flows out at the other end of the tank. Devices are used to cause the flow to be distributed over some considerable depth, to prevent surface currents, and to take the effluent from the depth free from sus- 2184
pended matters. Under the conditions of absence of sunlight and aeration and of moderate heat, minute organisms of the class known as anaerobic bacteria develop in great numbers in the tank. This biological growth and activity produces a chemical decomposition of the retained organic matter of the sewage—a reduction of its compounds into parts, a large part passing off in the

2185 form of gases, a part as inorganic matter with the effluent, and a part as slit-like sludge or ash which is deposited in the tank. In many sewages a part is liquefied while yet in the organic state, and carried off in the effluent. Some effect may be found in the dissolved organic matter. A light floating mat forms and covers the surface. The
2186 process results in the removal of a large part of the putrescible organic matter in suspension and its reduction into less troublesome forms.

The process is continuous and self-regulating, no attendance or labor being required except for the occasional removal of the sludge. The formation of gas is quite active, the gas passing through the floating mat and also sometimes escaping in great accumulations at clear points in the surface. It is easily ignited, and after stir-
2187 ring the tank a hot flame may be formed, rising three or four feet from the surface. An analysis of the gas made by Dr. A. W. Palmer, of the University of Illinois, is as follows: Carbonic acid gas (Co2), 10.7 per cent. total volume; free nitrogen (N2), 27.8; marsh gas (CH4), 55.3; ethane (C2H2), 6.2.

An effort has been made to utilize this gas for heating and lighting purposes, but it probably
2188 will not prove financially successful.

The sludge at the bottom of the tank is a black, muddy looking silt-like deposit. The average of two analyses of sludge from the tank at Champaign, Ill., gave: Water, 60.9 per cent.; organic matter, 4.7 per cent.; inorganic matter, 34.4. The floating matter at the top contains 92 per cent. moisture, three per cent. organic matter and five per cent. inorganic matter. The sludge is of lit-
2189 tle value as a fertilizer.

The accumulation of sludge is relatively small, but as there is considerable inorganic matter suspended in the sewage, and as there must be some ash resulting from the reduction of the organic matter, and accumulation is inevitable. The amount of this is difficult to estimate, but it probably ranges from three to six cubic feet of dry matter per 1,000,000 gallons of sewage for the

sewage of American cities. Much of this is from suspended mineral matter of the sewage. In plants where sludge has accumulated very slowly the arrangements for the supply of the tank has been such that much of the suspended mineral matter was taken out before the sewage reached th tank. In many locations a preliminary shallow tank for retaining the heavier inorganic matter, arranged to be easily cleaned or flushed out, 2191
will reduce the septic tank sludge and will thus result in reducing the cost of removing sludge and also add to the efficiency of the tank.

The operation of the septic tank has been quite satisfactory. At Champaign the effluent has been sufficiently pure to permit its discharge into the creek, and no objectionable results have been noted in the water below. No odor is noticeable around the tank. A slight swamp-like odor is 2192
found in the effluent sewer. Inside the building the gases are very distinct, but the odors are not especially objectionable. When the contents are being pumped out the smell is much stronger, but workmen suffer no great inconvenience. The odor from the sludge when pumped into the pit is more noticeable, but does not prove objectionable. The tank at Exeter, England, which is really an experimental plant, continues to work 2193
satisfactorily, and the city is now constructing a large plant to treat the sewage from the whole city. The installations at Yeovil, Manchester and Leeds, all on experimental bases, show good results. These Cameron tanks closed. tanks, and sufficiently close that the inside air is under some pressure. In at least three places in England open septic tanks have been used on a large scale 2194
—Manchester, Leeds and Accrinton. In each case open chemical precipitation tanks were converted into septic tanks. A coating or mat soon formed over the surface, and the septic action was set up. At Manchester and Leeds, comparisons were made with the Cameron Septic Tank in operation at the same time, and the result shows almost no difference between the open and closed tank. Manchester is planning to use open tanks in its new nstalla-

tion. Accrinton has been using open septic tanks
for two years, and is now treating 1,250,000 gallons
per day by this process with satisfactory results.
The question of open or closed septic tanks is not
wholly one of exclusion of light and air by the roof.
The advocates of closed tanks claim that such ex-
clusion to a proper septic action, since the anae-
2196 robic bacteria thrive under such conditions. How-
ever, sewage generally contains no dissolved oxy-
gen. Even if the surface of the liquid were not pro-
tected from direct contact with the air by the float-
ing mat on the surface, the opportunity for absorb-
ing air while passing through the tank is very
slight, and the evolution of gas acts to decrease the
absorption of air. Light is fairly well excluded by
the floating mat. Certainly, direct sunlight is ex-
2197 cluded. It must be stated, too, that the cities using
these open tanks are in a climate where the cloudy
days are very numerous—particularly Manchester.
It is evident that an absolutely dark and tight tank
is not necessary. To my mind a matter of more
importance than the complete exclusion of light and
air is the maintenance of moderate and even tem-
peratures in the septic tank. High temperatures
seem to give strong putrefacive action accompanied
2198 by bad odors. Low temperatures reduce the bac-
teria and chemical activity. My observation indi-
cates that 55° to 62° Fahr. give the best septic
action, while temperatures above 65° and below 50°
Fahr. are objectionable. Although the sewage will
generally reach the tank between these tempera-
tures, to protect the sewage from extreme tempera-
tures will generally require a covered tank in such
a climate as ours, though not necessarily a tight or
2199 dark tank, both by reason of the severely cold
weather and the intense heat of summer. At Man-
chester in the coldest weather the temperature of
the effluent of the open tanks is less than 2° colder
than that of the coldest tank, but in our climate
the temperature sometimes falls 40° or 50° below
the winter temperature to be found at Manchester.

* * * * * * * *

The first purpose of the septic tank is to retain

and reduce the organic matter in suspension, but it seems to do more than this. The bacteria developed or the chemical compounds produced seem to put the sewage in better condition for further purificiation—at least for self-purification. At a time when the flow of water of the creek above the septic tank outlet, at Champaign, was a little less than the
volume of the effluent of the tank discharged into it, 2201
chemical analyses showed a marked improvement in the water of the stream in a distance of one and one-half miles; and while the dissolved oxygen of the creek water just above the tank outlet was at a little below the saturation limit and just below the tank, was at about half the saturation limit, samples taken at a point one and one-half miles below show an amount of dissolved oxygen 50 per
cent above the saturation limit. This rapid forma- 2202
tion of oxygen is partly due to the presence in large quantities of the Uglena Virivis, an organism which liberates oxygen in large quantities. The presence of an excess of oxygen is also a great stimulus to the chemical oxidation of the remaining organic matter.

The amount of purification affected by the septic tank depends upon the amount and condition of the
suspended matters. Where these matters are not too 2203
finely divided it may be expected to take out 75 to 90 per cent of the suspended organic matter an efficiency quite similar to chemical precipitation.

There is much diversity of practice in the size of septic tanks. English tanks have generally been constructed with a cubic capacity equal to 24 hours flow of sewage, though experiments there seem to show that there is little difference in results be-
tween tanks whose cubic capacity equalled 12, 24 2204
and 48 hours flow of sewage. In the United States, with dilute sewage, septic tanks with cubic capacity, equal to 2 to 4 hours flow of sewage have given good results. In discussing this question it seems to the writer that errors have been made in assuming (1) that the time required for passing through the tank is the same as that required to fill a tank of this capacity, or in other words, that the flow

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is uniform through the depth of the tank, and (2)
that the time of passing through the tanks governs
the efficiency of the purification. Concerning the
first matter, observations by the writer in passing
strong coloring matter through a tank having five
feet of depth of water showed a time of passing
through the tank equal to about one-third of that
2206 required to fill the tank, or, to put it in another
way, the effect is the same as for a velocity equal
to the actual velocity and a depth equal to one-third
the depth. If the mere mechanical action in the
tank governed the desirable rate of flow it may be
said that one hour's actual time in the tank with
this very slow velocity would give a low enough
velocity and a long enough time to allow the suspended particles to subside. As the retained
2207 organic matter is held until decomposed, the time
of flow through the tank has no bearing upon that.
To my mind, the governing consideration is the
space necessary to hold the floating or settled
organic matter until it can be acted upon without
being interfered with by organic matter retained
subsequently. For a tank of too small size, newly
arrived matter would cover matter not reduced, and
hence crowd it back out of reach or otherwise interfere with the fermentation process. Besides this
2208 limitation, a tank of a size which will not require
too frequent cleaning is desirable. For the sewage of most American cities where no storm water
is admitted, considering its extreme dilution, it
is probable that a cubic capacity equal to a flow
of sewage for six to ten hours will give as good
results as larger tanks."

In reply to the following question by Professor
2209 Turneaure "I would like to inquire from Professor
Talbot to what extent he found the English plants
removing the sludge from the septic tank, and what
method was employed in removing the sludge? I
have kept very close watch of the papers, and the
last information I had in regard to the Exeter
plant was that they had not removed any sludge at

 2210

all. I wondered if that was possible." I made the following reply:

"Prof. Talbot—Little definite information on the amount of sludge accumulating could be obtained and the conditions of operation are not wholly representative. The experimental tank at Exeter receives its supply of sewage from a main sewer after
it has passed through a large sand catch which 2211
removes much of the heavier inorganic matter, and the tank gets sewage with comparatively little mineral matter in suspension, and therefore is not representative sewage. The sand catcher is cleaned frequently. A large amount of sludge has accumulated in the septic tank, but as its capacity is so great it has not yet been cleaned. In the plant under construction, provision is made for removal
by pipes. At Accrinton the sludge is removed by 2212
the channels which were constructed for the chemical disposal tanks now used as septic tanks, and the sludge is run on waste land. The amount is materially less than when chemicals were used, and the sludge does not have the offensiveness of the old sludge. It may be said here that the saving in chemicals alone in the treatment of one and one-quarter millions of gallons a day amounts to one
thousand five hundred pounds a year. At Leeds 2213
the method used with the chemical treatment is followed—passage through a conduit to a well, pumping into lagoons, draining and drying and carting away. It was calculated that the sludge amounts to about thirty per cent of the total matter in suspension in the sewage, which of course is heavy with manufacturers waste. Including the large amount of chemicals used in the precipitation
process, the amount of sludge is probably one- 2214
fourth to one-fifth of the chemical process sludge. At Manchester the sludge from the precipitation tanks is pumped to a sludge reservoir, run into a sludge boat, and carried to sea, and that from the septic tanks will receive the same treatment."

The article in Engineering News of January 13, 1898, contained the first use of the term "Septic

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Tank" I had known of, and was also the first information I had of the use of the septic tank at Exeter, England. The term "sludge" was used throughout these articles to mean the solid matter accumulating in sewage tanks, whether these tanks were chemical precipitation tanks, separating tanks
2216 or septic tanks, or sewage tanks of any other name, —that is a mixture of this solid matter with water in any consistency in which it may be found. The tanks which I termed "separating tanks" and "sedimentation tanks" in the articles just quoted, are the same in form and action as I should now call "septic tanks," and the changes in the sewage going
2217 on in these tanks included more than a mere mechanical subsidence and separation, and the action involved what is now commonly known in sewage purification as "septic action."

The articles referred to in this answer include all that I have published on these tanks, so far as I now recall.

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Counsel for defendants offers in evidence the parts quoted in the foregoing answer from the various publications referred to by the witness, and as the same are therein quoted.

Complainant's counsel objects to the in-
2219 troduction of the various matters quoted and the answer of the witness with respect thereto, in so far as said matters are offered as evidence of any facts stated in such articles quoted, for the reason that such articles are not the best evidence of the facts therein set forth.

It is stipulated that the various publications referred to by the witness as above shall be produced in court at the hearing if either party so desires, to be read subject to the objection above noted.

Adjourned till Friday, August 4, 1905, at 10 o'clock A. M. 2221

August 4, 1905, met pursuant to adjournment; present as before.

Q. 10. Please state whether the tanks at Urbana and Champaign described in your foregoing answers were closed tanks, or the extent to which they were closed, either by their own construction or by the scum which formed on top of the sewage there- 2222
in. By "closed tanks" I mean tanks that excluded both light and air. If the tanks referred to were not closed in this sense, please state to what extent they were closed with particular reference to operation. A. The Urbana tank was covered with a plank cover which rested on the brick walls of the tank, and made a fairly close fit. Air could reach 2223
it only as it passed through the sewer from adjoining manholes, or through crevices which may have existed between the walls and the cover. It was not absolutely air tight, though it was substantially air tight as we should now expect such tanks to be made. It cannot be said to have been absolutely light proof, but the construction was such that the 2224
condition of darkness prevailed so far as is necessary or desirable for the proper action of the tank and the growth and activity of the class of bacteria working in such tanks, commonly called anaerobic bacteria. The amount of air admitted would not be sufficient to permit absorption by the liquid to interfere with the action of the bacteria.

2225

The first Champaign tank was covered in a way such that the conditions so far as exclusion of light and air are concerned were practically the same except that there were no manholes on the tiles feeding the tank. The second tank at Champaign was built so tight that within the tank darkness
2226 prevailed to such extent that one could not see any objects around him, and there was no chance for air to escape except through the shingles or through small crevices which may exist in the construction of such buildings as this. It was not obsolutely air tight or light tight, but was sufficiently so to provide desirable conditions for the proper action
2227 of such a tank.

Q. 11. Please state whether you were familiar with the Mouras patents and Philbrick and Waring publications, and other literature bearing on the subject of sewage disposal at and before the time you designed and constructed the first tank at Urbana; and if so, whether you were then working or
2228 intending to work along lines already understood in the art?

> Complainant's counsel objects to that part of the question that calls for an expression of the witness's intentions or purpose, as not proper or competent evidence.

2229 A. My attention was first called to the Mouras construction by the letter from Mr. Noyes quoted in my answer to question 5, and I read the article in the Engineering News therein referred to. I was then using "Waring's Sewerage and Drainage" and knew of Waring's work in other ways. I also had seen the article of Edward S. Phillbrick and had a reprint of the article entitled "The Disposal

of Sewage in Suburban Residences." These writings referred to means for so reducing the solids in sewage that further treatment might be more effectively carried out, and indicated to me that tanks of the kind put in would have a beneficial effect. I felt from my knowledge of the subject
derived from such publications and from my ob- 2231
servation of sewage disposal plants that the use of such forms of tank had been sufficiently developed to warrant my recommendation to the city council of Urbana of the construction of the tank and the accomplishments of the results of getting an effluent sufficiently pure, clear and odorless to meet the
requirements of the town. 2232

Q. 12. Please state whether you have examined the Cameron, Commin and Martin patent, No. 634,-423, sued on in this cause, and whether you understand the same? A. Yes.

Q. 13. Please state whether you have ever seen any of the Cameron septic tanks so-called, and if
so, when and where, and what opportunities you 2233
had for inspecting or studying the same? A. I saw the Cameron septic tank at Exeter, England, in July, 1900, and the beginning of the permanent Cameron septic tank then being there constructed. I saw the Cameron septic tank at Manchester, England, in August, 1900, and the Cameron septic
tank at Leeds, England, during the same month. I 2234
was shown these tanks by attendants or chemists in the employ of the engineering department of these towns, and was given information concerning their construction, mode of operation and results.

Q. 14. Please compare the construction and operation of the tanks at Urbana and Champaign

2235 described in your foregoing answers with the construction and operation of the Cameron tank described in this patent No. 634,423, and state wherein they are similar to or different from each other either in construction or operation—limiting your comparison to claims 1, 2, 3, 4, 5, 6, 7, 8, 11,
2236 12, 20, 21, and 22 of the patent. A. The tanks in question receive sewage continuously, the amount of inflow being practically the same as the outflow at any instant. Light and air is substantially excluded and anaerobic bacteria are developed and the resulting biolytic action results in a breaking down and separation of the parts composing the
2237 organic matter in suspension in the sewage. The construction of the tank is common in that arrangements are made to provide a steady regular flow through the tank free from agitation and disturbance. The condition of the effluent is similar, both in regard to freedom from suspended sludge, and the conditions involving odor and appearance.
2238 Sludge was forming in the bottom of these tanks in the same way that it formed in the tanks at Urbana and Champaign, and the amount of this sludge, so far as I could determine from the information given me at the works was not materially different in amount or character when the difference in the dilution of the sewage, the proportion
2239 of organic matter in suspension to that in solution, the presence of catch-basins and grit chambers is taken into consideration from that deposited in the tanks at Urbana and Champaign in the early years of their operation. The tanks at Urbana and Champaign were not absolutely air tight and light proof, while the English tanks were so tight that

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the gas involved was held under some pressure in the tanks. But I was informed by the chemists connected with the department in charge of these works, at Manchester and Leeds, that this condition of absolute air-tightness and freedom from light was not in any way essential to the satisfac-
tory operation of such tanks, and that tanks which 2241
they were operating and which did not contain this feature were giving results every bit as good and that they could see no difference from this feature of the construction. The scum which formed on these English tanks was similar to that forming on the tanks at Urbana and Champaign. The tanks
at Urbana and Champaign contained a device for 2242
securing a steady outflow from the full section of the tank which differed from that in use in the Cameron tanks.

With reference to the specific claims of the patent, the tank at Urbana used the process mentioned in claim 1 in that the sewage was subjected under
exclusion of air, of light, and agitation, to the 2243
action of anaerobic bacteria until the whole mass of solid organic matter contained therein became liquefied, if by a whole mass is understood substantially all, and if by liquefied is meant that these solids are decomposed and that the effluent is almost entirely free from such solids. If by liquefy
is meant the changing into liquid, this would not 2244
well describe the process. The effluent was discharged into a small stream. If the exposure to air and light therein may be considered a part of the process, then the effluent was exposed to air and light.

In claim 2 the features of liquefying the solid

matter contained in the sewage consisting in seclud-
ing a pool of sewage having a non-disturbing inflow
and outflow from light, air and agitation, until a
mass of micro organisms has been developed of a
character and quantity sufficient to liquefy the
solid matter of the flowing sewage, the inflow serv-
2246 ing to sustain the micro-organisms and then sub-
jecting such pool under exclusion of light and air,
and under a non-disturbing inflow and outflow to
the liquefying action of the so cultivated micro-
organisms until the solid organic matter contained
in the flowing sewage is dissolved were used in the
tanks at Urbana and Champaign, if by dissolved is
2247 meant the breaking up of the organic matter. If by
dissolved is meant put into the form of a solution
which was entirely carried out in the effluent, and
that no part of the organic matter was retained in
the tank or given off as gas, the clause does not
describe the action in the tank. In both claims 1
and 2 I do not now understand that complete and
2248 entire exclusion of light and air is intended by the
wording. If it is these tanks were not so operated.

Claim 3 seems to cover the same as claim 2, with
the addition of subjecting the liquid outflow to an
aerating operation. If by an aerating operation is
meant an operation where gases may be given off
and air absorbed this feature was present in the
2249 tanks in question.

Claim 4 contains an additional process of filter-
ing. There was no filter connected with these
tanks, although the project of sewage disposal
planned by these two towns at that time involved
this addition at a future time.

With reference to claim 5, the outlet to the tanks

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at Urbana and Champaign was disposed above the bottom and below the normal water level of the tank if the weir wall and the baffle board next to it be construed as included in the outlet to the tank, and this outlet was open across the greater part of the width of the tank. If "outlet" be construed to
mean only the vertical plane at which the sewage 2251
left the deep part of the tank, that is the plane immediately above the weir wall, then the outlet was not disposed below the normal water level of the tank. If by an "aerator" is meant a device for performing aeration as defined in my statement concerning claim 3 made above, then there was an aerator connected with the outlet. 2252

Concerning claim 6, there was no settling tank in addition to the septic tank, using those words as they were evidently intended in the claim, in the plants at Urbana and Champaign. The other apparatus was included in these tanks, if the definition of the outlet is construed to include the part of the
tank weir wall to the next baffle board, otherwise 2253
the outlet was not disposed below the normal water level of the tank.

Referring to claim 7, there was no conduit having a longitudinal slot open across the greater part of the width of the tank. This answer is made construing the space between the last baffle board and the weir as not being a conduit. 2254

Referring to claim 8, the outlet in these tanks did not contain a pipe extending across the greater part of the width of the tank.

Referring to claim 11, if the term "inlet" be construed to include the part of the tank at the point of inflow up to and including the nearest baffle

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board, then there was an inlet disposed above the bottom of the tank and below the normal water level thereof, and occupying the greater part of the width of said tank. If the term "inlet" refers only to the vertical plane of the cross section of the tank at the extreme end thereof, then there was not an
2256 inlet disposed above the bottom of the tank and below the normal water level thereof, and occupying the greater part of the width of the tank. The part of the claim referring to an outlet extending across the greater part, etc., is covered in the answers above.

Referring to claim 12, these tanks did not have
2257 an outlet comprising a pipe having a longitudinal slot therein extending the greater part of its length. The remainder of the claim is the same as has been discussed in the answer above.

Referring to claim 20, these tanks had means for excluding air and light, that is, to such a substantial degree as is necessary for the proper operation of
2258 such tank, but they did not exclude light and air absolutely. The tank at Urbana did not have a broadened mouth if the word mouth is restricted to the vertical plane extending over the cross section of the tank at the influent end. The tank at the Champaign outlet had a broadened mouth. The expressions concerning the non-disturbing inlet
2259 disposed below the normal water level have been discussed in the answer above, as was also the part referring to a non-disturbing outlet for said tank disposed below the normal water level thereof. The flow from these tanks was over a weir wall extending across the whole width of the tank, and if this be construed to be a broadened mouth, then they

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contain a broadened mouth. A sewage conduit was connected with the inlet.

Referring to claim 21, the process of liquefying the solid matter contained in the sewage which consists in secluding a pool of sewage having a non-disturbing inflow and outflow from light, air and
agitation, until a thick scum is formed on the surface thereof, and a mass of organisms have been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms and then subjecting said pool under the cover of said scum and under a non-disturbing inflow and out- 2261
flow to the liquefying action of the so cultivated micro-organisms until the solid matter contained in the flowing sewage is dissolved was used in these tanks if "non-disturbing inflow and outflow" and seclusion from light, air and agitation are construed to mean substantial freedom from disturbance and substantial exclusion of light, air and agitation, 2262
and not absolute freedom from light, air and agitation; and if the expression "until the solid matter contained in the flowing sewage is dissolved" implies the decomposition and reduction of the suspended organic solid matter into gases, stable organic compounds, inorganic matter and matter soluble in water, and if this claim implies that not 2263
absolutely all of the said organic matter is so decomposed. If the claim be construed to mean that all solid matter including inorganic matter carried in the sewage, or even absolutely all of the organic matter of the sewage, then the process was not so used in these tanks. If by dissolved is meant the chemical use of the term, putting in solution where 2264

2265

it had previously been in suspension as the prin-
cipal part of the process, then these tanks were not
so operated.

Referring to claim 22, these tanks did contain an
apparatus for the purification of sewage, the com-
bination of a septic tank, means for excluding air
2266 and light, a non-disturbing inlet for said tank dis-
posed below the normal water level thereof, a non-
disturbing outlet for said tank disposed below the
normal water level thereof, and a sewage conduit
connected with said inlet, if by means for excluding
air and light is meant the substantial exclusion
thereof, if a non-disturbing inlet disposed below the
2267 normal water level is construed to include the part
of the tank as far as the first baffle board, and if
outlet disposed below the normal water level is
construed to include the part of the tank from and
after the baffle board nearest the outlet. If the
term inlet be restricted to a vertical cross section
plane at the influent end of the tank then the inlet
2268 was not disposed below the normal water level.
If the outlet of the tank be construed to mean the
vertical cross section plane where the water leaves
the deep art of the tank and no other portion of
the structure, then the outlet was not disposed
below the normal water level thereof. These ans-
wers are given with the understanding that the
2269 meaning of the expression "disposed below the nor-
mal water level thereof" means that every portion
of the inlet and every portion of the outlet must
be below the normal water level and not that the
said inlets or outlets may extend from the surface
of the water and not to some point below.

In using the word "outlet," I have referred to the part where the sewage would leave the deeper part of the tank and not to any chamber, conduit, or pipe which may be provided beyond that point.

> Complainant's counsel objects to such portions of the foregoing answer as relate to the tanks at Exeter, Manchester and Leeds and their operation as being hearsay and not proper evidence. 2271

Q. 15. Taking the word "septic" as used in the Cameron patent sued on, and as now understood in the art, did or did not the tanks at Urbana and Champaign described in your foregoing answers, produce or secure septic action? A. As I now understand the use of the term "septic action," as commonly used in connection with sewage purification plants and as used in the Cameron patent, the tanks at Urbana and Champaign did produce and secure septic action. 2272

Cross-examination by Mr. Fisher.

XQ. 16. When did you first construct or direct the construction of a sewerage system, and where? A. I think it was in 1883 that I had to do with the construction of a sewer, receiving tank, and subsurface irrigation system from the Santa Fe railroad hospital at La Junta, Colorado. 2273

XQ. 17.. When did you first construct or direct the construction of a sewerage system involving a tank in which the separation of suspended solids was effected by sedimentation? A. If by separation of suspended solids by sedimentation is meant that as a part of the process the suspended solids subside or are retained in the tank by reason of differences in specific gravity and a slow current, 2274

then the tank at Urbana constructed in October,
1894, was the first.

XQ. 18. When did you next construct or direct
the construction of a sewerage system involving a
sedimentation tank, such as specified in my last
question? A. Using the term "sedimentation" in
2276 the same sense as in the last preceding answer, the
next tank was constructed at Champaign in June,
1895.

XQ. 19. And when next after June, 1895, did
you construct or direct the construction of a sewer-
age system involving a sedimentation tank of any
kind? A. Using the term "sedimentation" in the
2277 same sense, the next sewerage system in which the
design of such a tank was included was designed in
the summer of 1895, but this system was not com-
pleted entirely until 1899. I refer to the Cham-
paign sewerage system.

XQ. 20. What sewerage systems other than those
which you have mentioned as having designed and
2278 constructed for Champaign and Urbana, were
designed or installed by you between the years 1894
and 1897? A. One for Charleston Illinois, and one
for Monticello, Illinois, are all that I now recall.

. XQ. 21. When was the system for Charleston
designed and when was it installed? A. It was
designed in June, 1896, but as I had nothing to do
2279 with the construction of it I do not now recall when
it was installed.

XQ. 22. When was the Monticello system de-
signed and installed? A. As I recall it, it was
designed in the summer of 1896 and constructed in
the fall of the same year.

XQ. 23. State the character and dimensions of

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the tanks forming part of the Charleston and Monticello systems to which you have just referred? A. I have not the data here concerning the tank at Charleston, and it has been so many years since this design was made I do not feel like attempting to give it from memory. There was no tank used
in the Monticello system as the outlet sewer dis- 2281
charged into the Sangamon River where the flow was sufficient to receive the sewage without any objectionable results.

XQ. 24. What sewerage systems have been designed or constructed by you or under your direction since 1894 other than those mentioned in the
course of your cross examination? A. In answer- 2282
ing this question you may restrict your answer to systems involving sewage disposal tanks or plants? A. Within the meaning of this question as I understand it, there has been none.

XQ. 25. State as nearly as you can now recall the construction and dimensions of the tank de-
signed by you for Charleston, Illinois? A. I do 2283
not now recollect the dimensions well enough to make a reply to this question.

XQ. 26. Can you not give an approximate statement as to the size and construction of the Charleston tank which you say you designed? A. It was designed along the same lines as the tank construct-
ed later at the Champaign sewer outlet. As I do 2284
not even recall how large a part of Charleston was to be included in the system, nor what the limitation of the amount of sewage passing to the tank was, I cannot attempt to give these figures.

XQ. 27. Was there any written contract between you and the city of Urbana in regard to the con-

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struction of the Urbana tank or system concerning which you have testified? A. There was none.

XQ. 28. When was the tract of land purchased for the Urbana plant? A. I think it was in July, 1894, that the city acquired the right to this land, or made arrangements for its purchase.

2286 XQ. 29. Did you make any recommendations or submit any plans or suggestions in writing with respect to a sewerage system for the city of Urbana, or for the city of Champaign? A. The work of the design and construction of the sewerage systems for Urbana and Champaign was left almost wholly in my hands, and although I consulted freely with
2287 members of the council, and particularly with the mayors and members of the sewer committee, very little of my intercourse with them was in writing. The only plans and reports which I now recall making were the plans for the sewer systems, the specifications for the sewer part of the work, and the ordinances for the construction of the sewerage
2288 systems. The plans referred to for the Urbana tank and the tank for the Champaign sewer outlet in the direct testimony were submitted to members of the councils.

XQ. 30. Did you submit no written description or drawings or sketches with respect to the Urbana or Champaign tanks other than the sketches and
2289 drawings that have been introduced in evidence, and other than the ordinances concerning which you have testified? A. I do not now recall what plan or sketch for the Champaign separating tank may have been made before the prints which have been introduced in evidence. There must have been such plans but I do not remember concerning them.

Other than these I do not now recall any other plans or writing.

XQ. 31. Did you construct the Urbana or the Champaign tank under the direction or superintendance of anyone or were you at liberty to follow your own views and desires with respect to these tanks? A. This work, as was the work on the en- 2291
tire sewer system, was under the direction of the city council and sewer committee of that body, and I of course acted under their direction. While they generally agreed with me I was careful to secure their approval. The question of the cost of the system was strong in their minds as the expenditure of funds for the construction of the sys- 2292
tem seemed a large one to them and required an effort in getting sufficient funds, and so the sizes and expenditures were questioned in every part of the system and this extended to the tanks at the outlet. I was limited by them in the expenditure on this part of the work.

XQ. 32. Did not your advice control with respect 2293
to matters which you regarded as important or essential in the different parts of the systems? A. In a general way, yes; but under the circumstances it seemed to me best to accede to their ideas of economy and present expenditures insofar as it would not interfere with the immediate working of the system—acceding to their stand that addi- 2294
tions or enlargements of the system could be made in the future when the city was better able to make the construction.

XQ. 33. Were any drawings made of the Urbana tank other than the drawings or sketches that have been introduced in evidence. A. Not that I now recall.

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XQ. 34. Before the contract for the Urbana sys-
tem was let and before the contract for the Cham-
paign system was let, were there any advertise-
ments for bids on these contracts? A. There were
such advertisements for that part of the system in-
volved in the pipe sewers and manholes and flush
2296 tanks; but none for the tanks at the outlet. The
contractor who constructed the Urbana sewer sys-
tem was asked in October, 1894, after he had had
the contract for the pipe sewers two or three
months, to make a price upon the construction of
the brickwork of the tank, and the sewer committee
accepted his bid without securing other bids. The
2297 tank at the outlet to the Champaign sewerage sys-
tem was not let by contract as a whole, the portion
included in the tank proper at and below the level
of the sewage line was constructed under my direct
supervision by the day labor of city employees, I
ordering the material as it was needed. The brick
walls were built by one of the two contractors who
2298 were asked to set a price upon it. The same is true
of the woodwork on the doors and roof.

Adjourned till Saturday, August 5, 1905, at 10 o'clock A. M.

August 5, 1905, 10 o'clock A. M.; met pursuant to adjournment; present as before.

XQ. 35. Was the sewerage system which you
2299 say you designed for Charleston, Illinois, ever
installed there? A. A line or two of sewer was
constructed, but this did not include any part of
the overflow system, nor of the outfall sewer to
take the dry weather flow, nor any part of the dis-
posal works so far as my knowledge goes.

XQ. 36. Was there ever any tank, such as you

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say you designed for the Charleston, Illinois, system installed at such place- A. Not to my knowledge.

XQ. 37. Did you ever visit Charleston to ascertin what sewerage work had been done there after you furnished the design for the system? A. I have not visited Charleston since that time. 2301

XQ. 38. You have not visited Charleston since you furnished the design for the sewerage system at that place, have you? A. No.

XQ. 39. And you do not know whether your tank was installed in that system or not? A. Only so far as I have been informed by the man who has been acting as city engineer of Charleston and by 2302
residents of that place.

XQ. 40. And what did he inform you as to this tank having been built or not? A. As given in a preceding answer, he told me that the outfall sewer and disposal plant had not be constructed.

XQ. 41. Who was the engineer of Charleston, Illinois, to whom you have referred? A. Mr. Mil- 2303
lar, of Mattoon or Charleston. I do not recall his initials.

XQ. 42. In the memorandum book to which you have referred in the course of your direct testimony, do you find any reference to this Charleston system? A. The memorandum books which I have with me refer only to the work at Champaign and 2304
Urbana.

XQ. 43. You had separate memorandum books for the Urbana and the Champaign systems? A. Yes.

XQ. 44. Will you please refer to the Urbana memorandum book and read therefrom such items as relate to the tank designed by you for the Urbana system. A. I find in my book the following items:

"October 18, K. & I worked on settling basin plans, etc."

"October 19, grades calculated and details of settling tank considered in P. M."

2306 "October 20, I staked out settling tank and digging was begun."

"October 22, Settling tank digging progressed."

"October 24, Digging for settling tank nearly completed."

"October 25, Settling tank begun (brickwork)."

"October 26, Rain stopped work on settling

2307 tank."

"October 27, Settling tank nearly done."

"October 29, Brickwork on settling basin finished."

"November 3, Settling tank filled with water yesterday and today east wall fell in."

"November 5, Started to repair settling tank but

2308 Wilskey left. Election day."

"November 8, Steele on covers, settling tank, etc."

"November 14, K at settling tank."

"November 24, Settling tank plastering patched."

"December 15, Office work and inspected working of set. tank."

"All of these dates are in the year 1894, which

2309 year appears written on the face of the book; and I do not find any other references to the tank.

XQ. 45. Who is the person referred to in your last answer by the initial "K?" A. M. S. Ketchum, the one referred to in my direct examination.

XQ. 46. When did you make, or cause to be made, tests to determine the amount, velocity, and

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character of the sewage at Urbana? A. In the
Spring of 1895, gaugings made by one or more of
my students showed a daily flow of from 10,000 to
25,000 gallons per 24 hours. I do not now recall
when any other gaugings were made. The general
character of the sewage was inspected at the same
time and its general nature seen, I do not now 2311
recall that any chemical determinations of the sew-
age were made if it is intended to include this in
the word character.

XQ. 47. If I understand your answer correctly,
the only tests made or of which you are aware with
respect to the volume, velocity and character of the
sewage at Urbana, were the gaugings referred to in 2312
your last answer as having been made in the spring
of 1895. Is that correct? A. Gaugings were after-
ward made at various times, but I do not recall the
time or the amount. At these times the general na-
ture of the sewage was seen, but I do not now recall
that any chemical examination was made, though
it may have been done, but I think not under my 2313
direction. So far as I recall no other line of tests
was made at that time.

XQ. 48. If I understand you correctly, the gaug-
ings last referred to and the ocular examination of
the sewage, were the only steps taken by you and
that no chemical, biological or other tests of the
Urbana sewage were made. Is that correct? A. As 2314
I remember it, none was made under my direction.
whether any were made by the department of chem-
istry or of botany I do not now recall.

XQ. 49. How were these gaugings made by your
students? A. As I remember it, both by means

of measuring weirs placed in the manhole and by floats run from one manhole to another.

XQ. 50. What was the size and character of the sewer leading to the settling tank which you designed for Urbana? A. It was vitrified pipe 12 inches in internal diameter.

2316 XQ. 51. How many inhabitants were there in Urbana in the fall of 1894; and how many connections were made with this sewer pipe of the Urbana system. A. I think the population was about 4,000. I do not know how many connections were made with the sewer system.

XQ. 52. For what part or proportion of the city
2317 of Urbana was the sewerage system installed in the year 1894?. A. The pipe system was laid to take care of a part of the southwestern portion of the city. This included a portion of the university buildings then built.

XQ. 53. Did the sewer pipe that connected with your Urbana tank receive all the sewage from the
2318 sewerage system of Urbana? A. All of the sewer system put in by me discharged into this tank. Of course drains existed in this same territory and there were connections from houses and cesspools emptying into these drains, but these tiles did not discharge into the sewer system.

XQ. 54. Was the construction of the sewerage
2319 system installed by you at Urbana such that ground water or rain water could pass into the system at any point? A. The joints of the sewer pipe were cemented up, but ground water did enter the sewer as was shown by increased flow in times of wet weather. The tile which took the roof water from one of the university buildings was so arranged that

a limited amount of water would get into the sewer,
the excess discharging through a tile into a stream.
On another line of sewer the roof water from a
school building discharged into the sewer. These
arrangements were intended to give a flush to the
two lines having very flat grades, and was in addi-
tion to the flushing given by the flush tanks. 2321

XQ. 55. How many flush tanks were there con-
nected with the Urbana system and what was their
capacity? A. I think there were seven. The ca-
pacity of these was generally between two hundred
and fifty and three hundred gallons. Two of the
tanks, however, held about six hundred gallons.

XQ. 56. Did all the water from these flush tanks 2322
and the storm water from the roofs that were con-
nected with the sewer system pass through the
tank at the outlet of the system? A. All of the
water from the flush tanks and such of the water
from the roofs as went to the sewer passed through
the tank.

XQ. 57. What provision was made for prevent- 2323
ing any of the water from the roofs that were con-
nected with the sewer from entering the sewer? A.
The construction of the eavetroughs and down-
spouts was such that not all the rainfall would
reach the tile drain. Besides this a special manhole
was built in the tile drain and the pipe which con-
nected it with the sewer made of such size, and the 2324
bottom of the manhole so constructed that after
flow through this pipe had reached a certain amount
the excess of flow would be discharged over a broad
weir into a large tile drain which carried it on to a
stream.

XQ. 58. State approximately the size of the roofs that were connected with the Urbana system? A. I think the university building contained about 12,000 square feet of roof surface, and the school building about 2,500.

XQ. 59. And these roofs were provided with the usual gutters and downspouts adapted for roofs
2326 of such size; were they not? A. I do not know what the condition of the gutters and downspouts was. We merely connected them up as they were.

XQ. 60. And if I understand your testimony these downspouts were connected by tile drains to manholes, which manholes were connected by tiles to the sewer. Is that correct? A. Yes, if by tile is
2327 meant sewer tile.

XQ. 61. State if you are able to do so what was the size of the pipes that connected the manholes to the sewers? A. I think about six inches internal diameter, that being the usual size for house connections.

XQ. 62. In what way was the outlet of the Ur-
2328 bana sewer connected to the tank? A. Through an inlet chamber at the influent end. This chamber was built of brick, including the bottom and the walls, and was covered with a board cover. It contained the two gates mentioned in my direct testimony. The bottom was made flat except that the angles at the side were filled in a little with mortar.
2329 The bottom of the gate at the tank was on the same level as the bottom of the sewer and the bottom of the inlet chamber. It was about three feet long and three wide at one end and four feet at the other, all internal dimensions. It was about one and a half feet from the bottom of the chamber to the top of the brickwork.

XQ. 63. How did the chamber at the outlet end of the sewer pipe connect with the receiving end of the tank? A. The cast iron frame of the gate was set in the brick wall at the influent end of the tank.

XQ. 64. What kind of a gate was used at the influent end of the tank? A. A flap valve or gate hinged at the top. 2331

XQ. 65. What was the size of the opening at the influent end of the tank, and how far was this opening above the bottom of the tank? A. About twelve inches. The bottom of the opening was about three and a half feet above the bottom of the tank.

XQ. 66. How do you account for the fact that the sketches made by you or under your direction of the Urbana tank do not show any cover? A. The sketches were made for the purpose of directing the construction of the brickwork; and the construction of the cover was left to the street department. 2332

XQ. 67. How long had the tank at Urbana been built before the cover was put on? A. I do not recall the exact date of the construction of this cover, nor whether it was put on before sewage was admitted, but it was constructed either in the last week of November, or in the first ten days of December, 1894. By constructed I mean that it was built in place on the tank. 2333 2334

XQ. 68. When were the baffle plates or boards added to the Urbana tank? A. Either before the cover was constructed or at the same time.

XQ. 69. How far was the baffle plate located from the inlet of the tank and how far did it extend below the bottom of the inlet opening? A. It was about three feet from the inlet end, and extended ten or twelve inches below the bottom of the inlet opening.

XQ. 70. How far below the bottom of the inlet to the tank did the brick wall extend—I mean the brick wall that was built across the upper part of
2336 the tank? A. About twelve or fifteen inches.

XQ. 71. How high above the bottom of the inlet of the tank did the baffle plate nearest the inlet extend? A. I think the baffle consisted of two boards each about twelve inches wide. This would make it twelve or fourteen inches above.

XQ. 72. How near to the weir adjacent to the
2337 outlet end of the tank was there a baffle plate, and how high above and below the line of the weir did such plate extend? A. About three feet from the weir and it extended down about 12 inches below the level of the weir and about the same distance above.

XQ. 73. And were the several baffle plates ar-
2338 ranged about at equal distances apart throughout the tank? A. I think so.

XQ. 74. What were the dimensions of that part of the tank beyond the weir at its discharge end? A. It was the full width of the tank, four and one-half feet, and two feet in the direction of flow. The bottom of it was about two feet and a half below
2339 the brick masonry. The drawing is marked that the bottom was twelve inches below the top of the weir wall; but upon examining the drawing and noting the distance given for the position of the outlet pipe I am not sure that this is exactly correct. Either the wall was two or three inches higher than this or the outlet pipe was two or three inches

lower than shown, for I remember that the sewage fell over the weir wall for small discharges of the sewer as it generally discharged in 1895.

XQ. 75. In what way were you able to observe the action of the discharges over the weir wall in 1895? A. By raising the plank cover, as we did when it was inspected and when it was cleaned. 2341

XQ. 76. Did the cover extend over the entire tank? A. The cover extended from the inlet chamber to the end of the wall at the outlet pipe and was made in two portions.

XQ. 77. State the size of the outlet pipe and how it connected to the pipe that led from the tank to the creek? A. It was a twelve-inch sewer pipe set 2342
in the wall, and it connected with the pipe that led to the creek by the ordinary method of connecting hub and spigot sewer pipe, and the joints were cemented in the same way as was done in all the sewers.

XQ. 78. How far was the tank at Urbana located from the creek? A. I think 20 or 30 feet.

XQ. 79. Was there an opening for sludge formed 2343
at or near the bottom of the Urbana tank? A. As stated in my direct testimony, a sludge gate was built into the brick wall near the bottom of the tank, but this was not connected with an outlet and was sealed up.

XQ. 80. Was the sludge gate above or below the level of the ground outside of the tank? A. It was 2344
below the level of the ground.

XQ. 81. How did you happen to put in this sludge gate? A. I thought it might make a convenient connection in case we desired some other way of removing the sludge than was planned at that time, and would save breaking into the wall of the tank.

XQ. 82. How far below the top of the weir was
the bottom of the outlet of the tank?. A. Two or
three inches as I remember.

XQ. 83. Did Mr. Ketchum make any suggestions
with regard to the construction of this Urbana tank,
or with regard to its proportions? A. I presume
2346 that he did, but I do not now recall anything con-
cerning them.

XQ. 84. Were any other drawings of the Ur-
bana tank made besides the two sketches that had
been offered in evidence or was any photograph
made of the tank? A. I do not remember of any
other drawing, nor that any photograph was made
2347 of the tank, though I do not know what students or
others may have done.

XQ. 85. Did you ever verify the measurements
of the Urbana tank after its construction to see
how they corresponded with the measurements of
the drawing you have introduced in evidence? A.
I do not now recall making such verification.

2348 XQ. 86. Was there anything applied to the Ur-
bana tank that is not shown on Defendants' Exhibit
Urbana Tank, November, 1894, besides the cover
and baffle plate? A. Only the gates.

XQ. 87. What was the cost of the Urbana tank?
A. The Dubuque Construction Company, the same
company which built the sewer system was paid
2349 about one hundred and twenty dollars for the exca-
vation and brickwork. The original price was one
hundred dollars but a cross wall was added and
additional grading done. I take these figures from
the final estimate book which was made up at the
time and have also referred to the bill put in by the
Dubuque Construction Company. This amount

does not include the cost of the cast iron gates which were made at a local foundry, nor of the cover and baffle boards.

XQ. 88. Why was not the cross wall included in the original bid? A. After the east wall had fallen in by reason of water getting behind it while the brickwork was yet green, it was decided to replace 2351
the baffle which was planned at the middle with the brick cross wall in order to strengthen the construction. This falling of the wall was mentioned in the quotation from the memorandum book made in a preceding answer.

XQ. 89. Were any changes made in the Urbana tank after the tank was put in operation first? A. 2352
I cannot say concerning this for after the first year or two I did not know of its operation, but during that time there were no changes made so far as I am aware.

XQ. 90. State as nearly as possible when the first test was made for determining the amount of sewage that passed per day through the Urbana tank? 2353
A. I cannot give the exact date when regular gaugings were made, except that it was in the spring of 1895. However, I inspected the outlet sewer several times in the winter of 1894 and 1895 and the spring of 1895, and measured the depth of flow in the outlet sewer. From this and the depth found at the time gaugings were made I was able to make 2354
a fair estimate of the quantity of sewage flowing at these other times.

XQ. 91. State if you know how many gaugings were made in testing the Urbana sewage in the spring of 1895? A. I do not know exactly how many were made.

XQ. 92. Was the flow through the Urbana tank continuous or intermittent? A. It differed at different times of the day, and varied from day to day. It was of course a continuous flow.

XQ. 93. How often did you examine the Urbana tank after it was installed. A. I cannot answer
2356 this question in a very definite way, but as often as I was at the outlet and the cover was so that it could be lifted. I presume that this was a half dozen times in the first year of its operation. Of course the effluent could be seen at the outlet to the tank where it discharged into the stream, and this was seen more frequently.

2357 XQ. 94. Did you ever observe the Urbana tank at a time when there was an excessive flow through the sewer and into the tank? A. I did not.

XQ. 95. When did you last examine the Urbana tank and in what way did you make your examination? A. As stated in my direct testimony, I visited this tank August 1; but I did not make any
2358 special examination of it for it was not in service.

XQ. 96. When, prior to August 1, 1895, did you last examine the Urbana tank, and when did that tank go out of service? A. I do not now recall when my last examination of this tank was made. As stated in my direct testimony I am informed that the tank was disconnected in July, 1905.

2359 XQ. 97. Did you examine the Urbana tank at any time between the year 1895 and 1905, and during that time did you make any tests to determine the manner in which the tank was operating? A. I visited the tank several times, and during the period mentioned, and at different times opened the cover and looked into it. I do not remember of making any test of the tank during this time other than a general inspection of the contents and of the sludge and of the effluent.

XQ. 98. About how often during the year 1896 and how often during the year 1897, did you examine the Urbana tank? A. I cannot say definitely concerning this, but I presume five or six 2361
times each year.

XQ. 99. What method was adopted by you for examining the sludge in the Urbana tank and in examining the effluent therefrom? A. When the sludge was taken from the bottom by means of a long shovel, or else a can was lowered on a stick.
When the tank was cleaned the sludge of course 2362
was deposited on the ground and this was scraped up. The effluent was caught in some sort of a vessel.

XQ. 100. Whose duty was it to clean the Urbana tank or to pump it out from the time the tank was installed and during the first three years there-
after? A. I think it was in the hands of the sewer 2363
committee of the Urbana city council who directed the street superintendent to have it done.

XQ. 101. Who was the street superintendent at that time? A. The street superintendent in 1894 and 1895 was Charles Sell. I do not recall who was street superintendent after that time.

XQ. 102. In the discussion following the paper 2364
which you have stated you read before the Illinois Society of Engineers and Surveyors at its Twelfth Annual Meeting, held January 27-29, 1897, I find the following coloquy reported as having occurred:

"Mr. Braucher wanted to know how the sludge was distributed over the surface.

Prof. Talbot replied that it was pumped into an ordinary tank on a wagon. The driver opened a spout on the back of the tank and the sludge was thin enough to distribute itself. Of course, only a small area was used for receiving the sludge.

Mr. More asked if the land was put in cultivation.

2366 Prof. Talbot answered that last summer part of it was used for a potato patch.

Mr. Rickar: 'What is the result on the surrounding country?'

Prof. Talbot said there was no effect on the surrounding country. There was no objection to it whatever. There was no odor. There might be some odor, when the tank was being emptied, if the tank had been permitted to become foul.

2367 Mr. Burnham suggested that if a single plowing was thrown over it, it would take away any odor.

Mr. Bond asked if there were any bad results from the sewage passing from the tank.

Prof. Talbot said that there had been some slightly bad conditions during the last season when there had not been sufficient water in the stream; but a year ago last summer, when the stream was dry, there were no bad results. At the worst, it was far better than direct discharge into the stream.

2368 Mr. Rickard: 'How often do you remove the sludge?'

Prof. Talbot: 'About once a month, ordinarily."

Is this report of the discussion that followed your papers substantially accurate? A. The report of these discussions was not made stenographically. The secretary of the society took down what he
2369 could and afterward wrote it up, but it was not submitted to the speakers I cannot now say just how accurate the report of the discussion is.

XQ. 103. I ask you to read over the report of the discussion as the same is given on pages 72, 73, 74, 75 and 76 of the Twelfth Annual Report of the Illinois Society of Engineers and Surveyors, and

state if the report of the discussion is not according to your recollection substantially accurate, and state also when you first had occasion to see this printed report of the discussion, and whether if at such time you observed any substantial inaccuracies? A. I do not remember the discussion very well and I cannot verify it except as it agrees with 2371
my memory of the situation at that time; and I do not remember the statement made by the people in the discussion except in one or two instances. The only conditions which could have been named "slightly bad conditions" in the stream referred to, on page 73 of the report, were farther down the stream and were due to secondary decomposition in 2372
stagnant pools. The statement that the sludge was removed about once a month was referred to in my direct testimony concerning the paper read at this meeting when I said I was afterward informed that the tank had not been cleaned as often as I then supposed. The question of Mr. More was with reference to the area with a 12 2373
inch sewer might serve and had no reference to purification. The statement that the additional population of the university could be considered 1,000, also had reference to that, and not to the amount of sewage then going into the sewer. The statement that "one-half the town was sewered" could not have been made for it is not an 2374
accurate statement. The statement that rain water from some of the buildings at the heads of the sewers is conducted into the sewer should be limited to the two buildings already mentioned, and the statement on page 74 that the overflow was designed to carry the excess of roof water beyond half of

2375 the capacity of the sewers is incorrect. I do not see that the statement concerning the sludge becomes liquid enough after two or three months could have been made by me, and I could not have made it. The report of these meetings generally came into my hands after their publication, but
2376 this was generally some time after the meeting and occasionally nearly a year elapsed before the reports reached me. I did not generally read the discussions, especially those of my own papers, and do not remember of ever reading over the report of this discussion until I looked it over the other day before I came to give testimony in this case.

2377 XQ. 104. The tank referred to in the matter quoted above from the discussion following your paper at the Twelfth Annual meeting of the Illinois Society of Engineers and Surveyors, was the Urbana tank, concerning which you have testified: was it not? A. As I remember, it was.

XQ. 105. Were you always present when the
2378 Urbana tank was cleaned or when the sludge was removed therefrom? A. No.

XQ. 106. Then of your own knowledge you do not know how often the tanks was cleaned out or the sludge removed therefrom? A. I do not.

XQ. 107. It may have been cleaned out as often as once a month, as stated in the report of the dis-
2379 cussion mentioned in the XQ. 102; may it not? A. My information came from people in Urbana and, as before stated, I did not of my own knowledge know how often the tank was cleaned.

XQ. 108. In what way was the cleaning of the tank effected? A. By stirring the sludge up and pumping out the contents of the tank with a sewer

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trench diaphram pump placed upon a tank wagon. After it had been pumped down nearly to the bottom sewage was again run in, the contents stirred and it was again pumped out. During this operation the discharge of the sewer was turned through the by-pass into the creek.

XQ. 109. Was the wagon built especially for the purpose of removing sludge? A. The tank of the wagon was so built. 2381

XQ. 110. Do you remember giving any instruction forbidding the cleaning out the tank oftener than once a month? A. I do not.

Adjourned till Monday, August 7, 1905, at 10 o'clock A. M. 2382

August 7, 1905, met pursuant to adjournment; present as before.

XQ. 111. You have stated in the course of your cross examination (XQ. 46) that in the spring of 1895 gaugings were made by one or more of your students, these gaugings relating to the Urbana sewage. Did you superintend the making of any 2383
of these gaugings or verify them? A. I constructed a portable weir which I placed in the manhole, and was with a student when part of these measurements were made. I also gave him directions concerning the work and helped to calculate part of them.

XQ. 112. Where was that manhole situated at 2384
which you placed the weir? A. On the outlet sewer a short distance above the tank, perhaps a thousand feet above.

XQ. 113. You do not recall I suppose how often these gaugings were made, or what the condition of the flow through the sewer was at the time any of

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the gaugings were made, do you? A. I do not recall exactly how many such gaugings were made, but I remember that they were made at different times of the same day, and on a number of different days. As I recollect it these observations were made under the usual conditions of flow of the
2386 sewage.

XQ. 114. Are you able to produce the memoranda or figures from which these gauging results were made? A. I am not.

XQ. 115. Why not? A. Because I do not have them in my possession.

XQ. 116. What became of them? A. I do not
2387 know.

XQ. 117. Were they ever in your possession? A. Some parts of the data were in my possession.

XQ. 118. When did you see or know of them last, or any part of them? A. I do not remember of seeing any of the original data since the time the gaugings were made.

2388 XQ. 119. Did you make any copies of the data about the time the gaugings were made? A. I presume I did, but if so it was made on loose sheets which were not kept.

XQ. 120. What became of such loose sheets? A. Such sheets would be destroyed.

XQ. 121. Do you know when such sheets were
2389 destroyed? A. I do not, but in all probability this was done in clearing up my desk soon afterward.

XQ. 122. You assumed that the gaugings concerning which you have testified and the estimates made therefrom fairly represented the normal flow of sewage to the Urbana tank in the spring of 1895?

A. These measurements, together with measure-
ments of depth of flow through the sewer made at
other times I took to represent the usual flow of
sewage.

XQ. 123. Did the outlet pipe that led from the
Urbana tank extend to the bed of the stream or
small creek into which the effluent discharged? A. 2391
It extended into the stream.

XQ. 124. Was the outlet end of this pipe at any
time submerged by the water of the stream? A.
Yes.

XQ. 125. Was it submerged at all times, or was
it intended so to be during the normal flow of the
stream? A. I think it was. 2392

XQ. 126. How high above the bed of the stream
was the Urbana tank located? A. As I remember
it, the weir wall was between two and three feet
higher than the ordinary level of the water in the
creek.

XQ. 127. In the course of your direct examina-
tion, and in answer to question 5 you stated with 2393
respect to the Urbana tank that it was at first ex-
pected that this tank might require frequent clean-
ing, "as was done in some places." Will you please
say what you meant by the above quoted expres-
sion "as was done in some places?" A. I knew
that at Marlboro, Massachusetts, and at Gardner,
Massachusetts, open tanks used to receive sewage 2394
were cleaned frequently. The purpose of these
tanks was merely to catch the solids and prevent
them from clogging the filters.

XQ. 128. Do you know how often it was custom-
ary to clean out such open tanks? A. I find by

2395 my notes that at Marlboro "present practice is to empty one chamber about once in two weeks running down sluiceway and on beds. Something wrong about plan—should not be so much sludge."

XQ. 129. Do you know whether the Urbana tank was ever cleaned or flushed otherwise than by
2396 pumping it out? A. I do not.

XQ. 130. Do you know whether the scum was removed from the tank or the sludge removed at any time except when the tank was pumped out? A. I do not.

XQ. 131. This might have been done, however, without your knowledge, might it not? A. It
2397 might.

XQ. 132. Did you make any memorandum as to the day when you first saw the Urbana tank cleaned out? A. I do not remember of any such.

XQ. 133. And of course of your own knowledge you do not know when the Urbana tank was first cleaned out, do you? A. Only as I recollect the
2398 time. I was at the tank some time during the period of the first cleaning at least when the men doing the work said it was the first time it had been cleaned out.

XQ. 134. Was the cover of the Urbana tank locked down or was it so that anyone could lift the cover? A. It was merely held by its own weight.

2399 XQ. 135. Was the Urbana tank neglected at any time, and if so did you ever have occasion to complain of such neglect? A. During the period in which I had occasion to visit the tank to the end of 1897 I do not think that I did. As the number of connections grew and the amount of sewage increased it is quite likely that the tank may have become too full of solids for its best operation.

XQ. 136. When was the Urbana tank first filled with sewage? A. In the latter part of November—some time after November 24th, 1894.

XQ. 137. Did you ever personally order or re- 2401
quest the Urbana tank to be cleaned out? A. I do not remember. I may have requested it to be cleaned.

XQ. 138. When did you first notice that the quantity of sewage passing through the Urbana tank was too great for its size? A. I do not now
remember. The quantity of sewage increased grad- 2402
ually and the efficiency of the tank finally became less and less.

XQ. 139. In the paper that you read before the Illinois Society of Engineers and Surveyors at its meeting in January, 1897, you refer to a tank at Oberlin, Ohio. Did you ever see that Oberlin tank?
A. Yes, in 1894 I saw this tank when I visited the 2403
sewage disposal plant there, but my attention was called to it only as a means of getting better results in the discharge of the sewage upon the land which was used as a means of disposing of the sewage. This land was not very sandy, and this method was taken to take out the solids.

XQ. 140. How was the Oberlin tank cleaned 2404
out? A. I do not now remember.

XQ. 141. When did you visit the Oberlin tank or first learn about it? A. In June, 1894.

XQ. 142. Was the Oberlin tank open or closed? A. I am not sure. I think loose boards were laid over the tank.

XQ. 143. Who constructed the tank which you have referred to as the first Champaign tank, and which you say was built in East Side Park, Champaign, June 13 to 15, 1895? A. It was built by employees of the city of Champaign under the charge of the superintendent of streets.

2406 XQ. 144. If you have a memorandum book containing data with respect to this Champaign tank, will you please produce it and read therefrom any memoranda that you find relating to the first Champaign tank? A. I find this entry:

"June 13-15, Settling tank built". I think this
is the only entry with reference to the first Cham-
2407 paign tank.

XQ. 145. In your memorandum book under the
date of June 13-15 I find the name Quade men-
tioned. Who was Quade? A. Mr. Qaude acted
as assistant engineer on the work of making the sur-
veys and designs for the Champaign sewerage sys-
tem. His full name is John C. Quade. His home
2408 has been Kewanee, Illinois and I think he can still
be reached at that address. He is now engineer on
some coal mining property owned by Mr. John
Pierce & Son, I think at St. David, Illinois.

XQ. 144-a. Were there any drawings made, or
sketches made of the design of this first Cham-
paign tank, either before or after it was construct-
2409 ed? A. I do not remember that any drawings or
sketches were made at any time.

XQ.145-a. Who was the superintendent of streets under whose direction you say the employees worked in building the first Champaign tank? A. Mr. Banes, who still lives at Champaign.

XQ. 146. This first Champaign tank was made by digging a hole in the ground and lining the walls of the hole with planks, I think you said. Is that correct? A. Yes.

XQ. 147. What was the extent of the sewerage
system at Champaign that delivered to this tank,
and when was the connection of the system to the 2411
tank made? A. There was no sewerage system.
The tile that connected to the tank was a tile that
took the flow at low water in the stream, which
came from tile drains in another part of the city.
It was connected with the tank at the time of the
construction of the tank.

XQ. 148. Will you please describe the sewage 2412
and drainage system of the city of Champaign at
the time you say you built the settling tank there
in June, 1895? A. There had been put in a series
of small tile drains to drain cellars and take some
surface water from the street. These tiles original-
ly drained into ditches and branches which were
generally dry. At some time or other a number of 2413
these tiles were connected up with the tile which
ran down the bed of Boneyard Branch, the connec-
tion being made in such a way that the flow in dry
weather time passed through this tile, while at
other times the larger part of it went into the
ditches and branches.

XQ. 149. Do you know how these small drain 2414
tile which you have said were designed to drain
cellars and take some surface water from the
streets were connected to the drain tile that ran
down Boneyard creek? A. I do not.

XQ. 150. Was the connection between these

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small drain tiles and the tile in Boneyard creek open connections or close connections? A. Will you please say what is meant by open and closed connections?

XQ. 151. Were the connections such as to insure that all liquid passing into the small tiles dis-
2416 charged into the tile in Boneyard creek? A. As I have already stated, part of the flow at times escaped into the ditches and branches.

XQ. 152. Can you not give more definite information to the court with respect to the kind of connections that existed between these small tile and the tile in Boneyard creek? A. No, I had nothing
2417 to do with their construction.

XQ. 153. If I have understood your testimony correctly, you have said that under certain conditions or at certain seasons the liquid that passed from the small drain tiles didn't all go into the tile in Boneyard creek, is that correct? A. Yes.

XQ. 154. How did the liquid that came from the
2418 small drain tile and did not pass into the Boneyard creek tile get out of the small drain tile and at what point? A. Through overflow tiles which led directly to these ditches or branches.

XQ. 155. What was the size of the tile in Boneyard creek and what the size of the small drain tiles leading thereto? A. I do not remember exactly
2419 the size. I think the tile along Boneyard Branch at the settling tank was 8 inches or 10 inches in diameter, and it was common farm drain tile. The other tiles ranged from 6 inches up, and were both farm drain tile and vitrified pipe. I do not remember the size of the largest tile.

XQ. 156. As I understand it, this Boneyard drain

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tile and the small drain tiles leading thereto were
designed, as you have said, for taking the water
from cellars and the surface of the streets and from
the ground? A. Yes.

XQ. 157. State if you know, to what extent this
Boneyard creek tile, or these small drain tiles, were
used or supposed to be used for other purposes than 2421
the drainage of water, as above stated? A. I can
only judge of this from the appearance of the discharge
at the outlet of the tile and the nuisance
created there, and by statements made to me by
plumbers and others concerning house connections
and cesspools. From this information I think there
must have been between fifty and one hundred 2422
houses and buildings having connections made from
water closets and cesspools, as well as a much
larger number of connections from kitchen sinks.
Such matters were kept very quiet for damage
suits had been instituted at different times on account
of the nuisance created by the discharge of
these drains. 2423

XQ. 158. In speaking of this matter a few minutes
ago did you not say, off the record, that these
water closets and cesspools were not supposed to
be connected with the drain tile concerning which
you have just been testifying? A. It is my impression
that the water closets were not supposed
to be directly connected. I am not sure regarding 2424
the cesspools.

XQ. 158½. The first Champaign tank was built
in the bed of Boneyard creek, was it not? A.
Along one side of the bed of that stream.

XQ. 159. How was the tank disposed with relation
to the stream? A. It was not quite parallel

with the direction of the stream at that point, and the bottom of it was five feet or more below the bed of the stream.

XQ. 160. How near did the tank extend to the bed of the middle of the stream? A. I do not recall exactly, but I think the channel was changed
2426 somewhat at one point to make room for the tank.

XQ. 161. How high above the bottom of the bed of the stream did the wooden wall of the tank extend?

At this point the examination of Professor Talbot was suspended to permit of the examination of Mr. John C. F. Sell,
2427 whose deposition will follow Prof. Talbot's in the record; and at the close of Mr. Sell's deposition an adjournment was taken until Tuesday, August 8, 1905, at 10 o'clock A. M.

August 8, 1905, ten o'clock A. M. met pursuant to adjournment; present as
2428 before.

Cross-examination of Prof. Talbot resumed.

A. As I remember it, a foot or two above the bed of the stream.

XQ. 162. What were the dimensions of the lumber of which the first Champaign tank was con-
2429 structed? A. I do not remember exactly. The length of the side boards was 16 feet, and the boards at the end of the tank were either 14 or 16 feet, and cut in two.

XQ 163. Of how many thicknesses were the walls of the tank? A. One thickness.

XQ. 164. Were the boards that formed the walls of the tank tongued and grooved? A. They were not. They were plain boards.

XQ. 165. Were the joints between the boards that form the walls of the tank calked? A. They were not.

XQ. 166. Of what material was the cover of the first Champaign tank formed? A. Boards. 2431

XQ. 167. Describe the construction of that cover? A. I do not recall the exact construction of the cover. Boards were placed either lengthwise or crosswise of the tank, and cleats nailed in the opposite direction to hold them together. That is as much as I can say about it.

XQ. 168. Was the cover formed in one piece? 2432
A. I do not remember about that, but I think there were either two or three pieces.

XQ. 169. Was the cover formed of tongued and grooved boards? A. I think it was built of plain boards, not tongued and grooved.

XQ. 170. Were the joints between the boards that comprised the cover calked or made tight in 2433
any way. A. They were not calked, merely placed close together.

XQ. 171. I think you have said this first Champaign tank was located along the stream known as Boneyard Branch, is that correct? A. I have so stated.

XQ. 172. Was there any other sewage tank 2434
located on or adjacant Boneyard Branch? A. Not to my knowledge.

XQ. 173. In wet weather the greater part of the surface and drainage water from the city of Champaign passed along Boneyard Branch, did it not? A. Yes.

XQ. 174. About how deep was the stream in wet weather? A. The depth of the stream varied from a dry condition when its entire natural flow was taken by the tile which went down the stream and which was the case generally in the summer and fall of such dry seasons as those of 1894 and
2436 1895, to a depth of a foot or two after a storm, and even to a depth of three or four feet during winter and spring floods in occasional years.

XQ. 175. After a storm or in very wet weather would the first Champaign tank be submerged? A. That would be the condition occasionally in wet seasons.

2437 XQ. 176. How was the cover of the first Champaign tank held in place? A. I do not remember about that. It may have been nailed down.

XQ. 177. Do you know when the cover was placed on the first Champaign tank? A. Yes, at the time it was built.

XQ. 178. Did you ever lift the cover off of the
2438 first Champaign tank, and if so when? A. I do not recall that I ever did.

XQ. 179. How long did the cover remain on the first Champaign tank? A. I do not know. I have said before that this structure remained there until a year or two ago, according to statements made to me, but I cannot say whether the cover was on until
2439 that time or not.

XQ. 180. When did you last examine this first Champaign tank? A. I do not remember of examining it since it was put into operation.

XQ. 181. You mean you do not remember examining it since June, 1895, is that correct? A. I do not recall whether I examined it or not since that time. I mean I do not recall whether I examined the interior of the tank.

XQ. 182. Do you know whether or not the first Champaign tank was ever cleaned? A. It was cleaned.

XQ. 183. Were you present when it was cleaned?
A. I do not now recall whether I was present or 2441
not. I remember seeing the sludge which was thrown out on the ground at the time of cleaning it.

XQ. 183a. But aside from seeing sludge on the ground adjacent to the tank you know nothing of your own knowledge concerning the cleaning of this first Champaign tank? Is that correct? A. My
memory is not clear on this point, and I am not 2442
sure whether I saw it cleaned or whether the statements of the condition which I remember were from information given me at the time by those who worked cleaning it out.

XQ. 184. State by whom this first Champaign tank was cleaned, if it was cleaned at all? A. By
the street department of Champaign. 2443

XQ. 185. Can you give the name of the person who cleaned the tank or took any part in cleaning it? A. It was done under the direction of superintendent of street, who was Mr. Banes, in 1895.

XQ. 186. How was the drain tile in Boneyard Branch connected to the first Champaign tank? A.
By running in to the upper end of the tank. 2444

XQ. 187. Was there a hole cut in the wooden wall and the sewer pipe run through the hole? A. That was the arrangement as I recall it.

XQ. 188. How far into the tank did the inlet pipe extend? A. I cannot say. It would be the nearest length that would be made by tile 12 inches

2445 long. I think, however, that the joints back were so arranged that it came flush with the end.

XQ. 189. How far below the top of the tank did the inlet pipe enter? A. I think the top of it was something like two feet below the top of the tank. I do not recall this exactly because I do not remem-
2446 ber exactly how far the tank extended above the flow line. This was left to the superintendent of streets to make as most convenient.

XQ. 190. Of what was the bottom of the first Champaign tank constructed? A. There was no floor to it; the only bottom was the hard material found at the bottom of the excavation.

2447 XQ. 191. How high above the water level of the tank did the inlet pipe enter? A. The water level of the tank was fixed by the outlet device at the end of the tank, which, as I remember it, would keep the water level during times of ordinary dry weather flow about two-thirds of the height of the tile above the bottom of the tile where it entered
2448 the tank.

XQ. 192. How far above the bottom of the tank was the outlet tile? A. The bottom of the tile was between three and four feet above the bottom of the tank.

XQ. 193. In testifying regarding this first Champaign tank and giving dimensions with respect
2449 thereto, have you simply relied upon your memory, or have you refreshed your memory by written memoranda? A. As I have said before, there were no plans or sketches of this tank made, nor any written memoranda, so far as I now recollect. I have talked with two laborers who worked on the building of the tank and on last Sunday I visited

the site of the tank and saw the portions of the
board sides which are still in existence there. The
bed of the stream has been changed since the time
of the construction of the tank, and its exact con-
dition at that time is a matter of memory with me.
The part remaining showed the tank had the length
and breadth which I gave in my testimony so far 2451
as I could check the matter up with my eye. I had
no means of making exact measurements.

XQ. 194. Who were the two laborers with whom
you talked about this tank? A. One was John
Demlow, and the other Charles Wilskey. They re-
side in Champaign.

XQ. 195. Did you notice whether the boards 2452
comprising the walls of the tank were warped or
not?A. I did not.

XQ. 196. Did you notice whether the joints had
separated or spread? A. I did not.

XQ. 197. Was the cover of the tank in position
when you saw the tank on Sunday last? A. It
was not. As I stated before, only the sides or parts 2453
of the sides remained. Nothing of the ends, so far
as showed above the bed of the stream.

XQ. 198. What was the distance from the first
Champaign tank to the outlet end of the drain pipe
leading therefrom? A. About half a mile.

XQ. 199. Into what did this outlet pipe dis-
charge? A. Into Boneyard Branch. 2454

XQ. 200. When did you first make or cause to
be made any tests for the purpose of determining
the character, volume or flow of the Champaign
sewage, or of the drainage passing through the tile
drain to which the first Champaign tank was con-
nected? A. I made no gaugings or tests. The

flow was estimated from the depth of water in the tile and the discharge at its end.

XQ. 201. Did you never make, or cause to be made, any tests or gaugings to determine the character, volume or velocity of the Champaign sewage? A. If by Champaign sewage is meant the flow
2456 through this tile which passed through East Side Park, I think the answer is included in the previous answer, and no other gaugings were made; nor were any chemical tests of the sewage made under my direction. I do not now recall what others may have done. The department of chemistry made analyses of this water at various times, but I had
2457 nothing to do with their work.

XQ. 202. Did you ever make or cause to be made any tests or gaugings of the Champaign sewerage system which you installed between the years 1896 and 1899? A. Yes.

XQ. 203. When did you first make such tests or gaugings, or cause them to be made? A. Soon
2458 after the outlet sewer was put into operation, which was about November 1, 1897, gaugings and measurements were made and this was done at various times in 1898 and 1899. Samples of sewage were also collected by students and analyses made by the department of chemistry. The analyses of gas was first made I think in December, 1897,
2459 soon after the tank was put into operation. An analyses of the sludge was also made, but I do not recall when this was done.

XQ. 204. What was the size of the inlet and outlet pipes of the first Champaign tank? A. The same as the size of the tile which I think was 8 inches or 10 inches.

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XQ. 205. Were there any baffle boards in the first Champaign tank? Or was there anything extending between the walls of the tank below the surface of the water? A. There were I think baffle boards across the tank at three points along the length of the tank, spaced so as to divide the length into something like equal parts. 2461

XQ. 206. Who built the first Champaign tank? A. It was built by city employees under the direction of the superintendent of streets, Mr. Banes. I do not recall the name of any other employe than the ones I have mentioned.

XQ. 207. Were you present when the tank was being built and when the cover was put on, and 2462 when the sewage was run into the tank? A. I was there part of the time. I had some difficulty in getting the superintendent of streets to go as deep with the work as I wanted. I was there, I know, after the tile had been connected and the flow turned in, and before the cover was put on. I do not recall being there when the cover was put on. 2463

XQ. 208. You do not know how long the tank was in operation before the cover was put on, do you? A. I do not remember.

XQ. 209. When did you first see the tank after the flow was directed to the tank? A. I do not remember the date. It must have been the last date given in my memorandum as the construction 2464 of the tank was completed at one operation.

XQ. 210. Do you know in what way the first Champaign tank was cleaned, or how often it was cleaned? A. I think it was cleaned by using some kind of a scoop or bucket which was put down into the bottom. I do not recall exactly about that. I

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do not know how often or how many times it was cleaned.

XQ. 211. What was the purpose of the screen which was used in the first Champaign tank and what was its exact location? A. It was put in at the suggestion of one of the city officials to retain
2466 rags or papers or other material which might get into the tank. As I remember it, it was placed underneath the last baffle board of the tank, the one nearest the outlet.

XQ. 212. When did you first learn that the action of this first Champaign tank was unsatisfactory? A. I do not remember of ever hearing a
2467 statement that it was unsatisfactory.

XQ. 213. When did you determine or discover that the Urbana tank was too small? A. I cannot say. The flow of sewage increased and the amount of solids passing into the tank also increased, so that the efficiency became less. Just when the tank became too small I do not know.

2468 XQ. 214. When did you first observe that the efficiency of the tank was seriously lessened? A. I cannot answer that, as I do not remember.

XQ. 215. Was it during the year 1895?. A. I should say that the flow was about the same through the spring of 1895 and that it increased in the fall of that year. I cannot say whether the efficiency
2469 became less during this season.

XQ. 216. How did you happen to be present at the Urbana tank at the time you first saw it cleaned out and how many men were there at the time? A. I do not know. I suppose that word was sent to me that the tank was being cleaned and I was asked if I wanted to come and look at it. I do not remember how many men were present, nor do I remember who were present.

XQ. 217. You were present yesterday during the whole time that Mr. Sell was giving his deposition, were you not? A. Yes.

XQ. 218. And you heard what he testified? A.
Yes. 2471

XQ. 219. Did you ever see Mr. Sell unlock the cover of the Urbana tank? A. I do not remember concerning a lock on the cover to this tank. The matter has entirely passed out of my memory. The second Champaign tank was locked and I carried keys to this tank, but I do not now recall anything
concering the lock and the Urbana tank. I have a 2472
faint memory about a lock now that I have heard Mr. Sell's testimony, but nothing definite enough to be able to make a statement concerning it.

XQ. 220. When the Urbana tank was cleaned, were both scum and sludge removed? A. Yes, so far as the cleaning was done, but of course the tank
was not completely cleaned out. The cleaning was 2473
done as far as it could easily be with the appliance and method used.

XQ. 221. Was the material in the tank first stirred up, then pumped out, and was sewage then admitted and the tank further pumped out, or if not, what was the operation of cleaning the Ur-
bana tank? A. That was the method used as I 2474
remember it.

XQ. 222. The purpose was to remove as far as possible all sludge and scum, was it not? A. The purpose was to clean the tank without special reference to what was in it.

XQ. 223. What did you estimate the flow of sew-

age at Champaign during the years 1895, 1896 and 1897? A. I think I stated that the usual dry weather flow through the tile which ran along Boneyard Branch was 60,000 to 90,000 gallons per 24 hours, as it appeared during the summer of 1895. I cannot say what it was at other times, except
2476 that when it was admitted to the outlet sewer in the latter part of 1897 it was less than this amount. The flow of sewage in the Champaign outlet sewer was, as I recall it now, about 100,000 gallons in the early part of 1898, and increased gradually through the year. This tile discharged into the sanitary sewer in a manhole where its flow could be observed,
2477 that is, this was the arrangement after connection was made with the sewer. The connection was made at a time when the ground was very dry, and very little ground water got into the tile.

XQ. 224. Did the sewerage system that you designed and installed for Champaign include this tile drain that ran along Boneyard Brach? A. No,
2478 it was no part of that system, but it was connected up with this system for a time.

XQ. 225. At what did you estimate the flow of sewage through the sewerage system designed by you for Champaign, exclusive of the amount of sewage that was to be received from the drain running along Boneyard Branch? A. At the time connec-
2479 tion was made with the tile drain in East Side Park I estimated that the amount of flow from the remainder of the system was, say fifty to seventy-five thousand gallons as nearly as I can now remember.

XQ. 226. What was the number of connections in your sewerage system at the time it was installed or first put into operation? A. I do not know any-

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thing about that. Connections had been made and the discharge of the outlet sewer turned into the creek before the time when connection was made with the septic tank at the outlet, but I had nothing to do with these connections and do not recollect how many had been made.

XQ. 227. How many miles of sewer system were 2481
there exclusive of the Boneyard Branch drain tile? A. There were eight or ten miles constructed before November, 1897, when the tank was put into operation. The entire system as designed in 1895 contained about 25 miles of sewer. A small amount of sewer was constructed in 1896, but none of this
was put into operation. The remainder of the eight 2482
or ten miles was built in 1897, up to the time when the outlet sewer was put into service in October of that year.

XQ. 228. So far as you know, was any attention ever paid to the first Champaign tank after the outlet pipe leading therefrom was connected up
with the outlet of the Champaign sewerage system? 2483
A. I do not remember definitely about this. Mr. Brower, the city engineer at that time, made some statements concerning it, and in some way kept watch of it, but I cannot say further than that.

XQ. 229. When did you last examine or test the effluent from the first Champaign tank? A. I do
not remember. 2484

XQ. 230. Did you ever make such examination, and if so, when? A. I examined the appearance of the effluent during the summer of 1895, but I did not myself make any tests of it.

XQ. 231. Did you ever examine the effluent at any other time than in the summer of 1895, if so when, and how often? A. I presume I saw the outlet occasionally, but I cannot say how often nor when.

XQ. 232. In what way did you direct the construction of the first Champaign tank? A. By outlining the size, shape and position of the tank,
2486 and of the baffles and outlet box, and being on the work at times to explain what was wanted to the street superintendent. The mayor had given instructions that the work was to be done according to my directions.

XQ. 233. What was the cost of this first Champaign tank? A. I do not know and I do not think
2487 I ever knew anything about this.

XQ. 234. In the paper that you read before the Illinois Society of Surveyors and Engineers in January, 1897, and in which you mentioned the Urbana and the Champaign tanks, you say: "It should be cleaned once a month to keep the tank in good condition." Did you instruct anyone as to how often
2488 the first Champaign tank should be cleaned? A. Not to my recollection.

XQ. 235. But your belief was that it should be cleaned about once a month to secure best results, is this correct? A. It was then my belief that a tank, such as was put in at Urbana, would be better off if it were cleaned as frequently as once a
2489 month. I did not understand very fully the working of such a tank. I do not recall anything concerning my views on the first Champaign tank.

XQ. 236. But that was you belief at the time you read your paper in January, 1897, was it not? A. I think it was my belief that such tanks would be better off if the time of their cleaning was not run over too great a period. The once a month probably referred to a general period of frequency rather than to a definite time.

XQ. 237. Were there any changes made in the first Champaign tank after June, 1895? A. I do not know.

XQ. 238. As I understand it, your testimony 2491
with respect to the first Champaign tank is based entirely upon your memory, except for a single item that you have quoted from your memorandum book. Is that correct? A. That and the appearance of the sides as I saw it last Sunday.

XQ. 239. Were there any connections to the
drain pipe that led from the first Champaign tank 2492
at points between the outlet of the tank and the outlet or discharge end of the said pipe? Yes, I so stated in my direct examination.

XQ. 240. Did such connections exist in June, 1895? A. I think they did.

XQ. 241. After you made the sketch for the Ur-
bana tank, when did you next make a drawing of 2493
a settling tank? A. I made such a drawing or sketch some time the last of June, 1895, or in July, 1895, at the time that I was working on the ordinance and plans for the Champaign sewerage system. I do not know what became of these drawings. I presume they were destroyed when the final plan
was made. 2494

XQ. 242. When did you next make a drawing of a settling tank? A. I do not now remember when the next drawing was made.

XQ. 243. When was the next drawing of which you have any recollection made? A. I think it was in the first half of 1896.

XQ. 244. Is that the drawing that you have offered in evidence as "Defendants' Exhibit Champaign Tank Drawing No. 1"? A. It is, if by the question is meant the next that was made under my general direction. This drawing in its details was made by the draftsman and I do not remember
2496 of approving the detail. The draftsman was R. P. Brower.

XQ. 245. When was the next design for a settling tank made by you or under your directions after this "Defendants' Exhibit Champaign Tank Drawing No. 1?" A. The next was the tank for Charleston, Illinois, made in June or July, 1896.

2497 XQ. 246. Have you made any effort to find any sketches of drawings or other data with respect to the Charleston design? A. Since the matter was asked for last week I have looked through the drawers where I keep such material and can find no trace of such.

XQ. 247. When, after the design for the Charles-
2498 ton tank was made, did you next make or cause the drawings to be made for a settling tank? A. Some time before the meeting of the Illinois Society of Engineers and Surveyors, which was held in January, 1897, a drawing was made for the cut which appears on page 71 in the published report of that meeting.

2499 XQ. 248. When did you next cause a drawing to be made of a settling tank? A. Some time after the completion of the second Champaign tank in August, 1897, but I do not remember when this was done. The drawing referred to is the one marked "Defendant's Exhibit, Champaign Tank, Drawing No. 2."

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XQ. 249. Did you make any attempts to instal settling tanks other than those mentioned by you in your testimony between 1894 and 1898? A. Not that I recall.

XQ. 250. In the course of your testimony where you have referred to the tank at the outlet of the
Champaign sewerage system you have meant the 2501
second Champaign tank; have you not? A. Yes.

XQ. 251. Who had charge of the cleaning of the second Champaign tank? A. The city engineer of Champaign.

XQ. 252. Do you know of your own knowledge how often this tank was cleaned? A. Only as I
have been told about it. 2502

XQ. 253. The cleaning of the second Champaign tank was effected by a centrifugal pump driven by a steam engine; was it not? A. Yes.

XQ. 254. What became of the material withdrawn from the tank by the centrifugal pump? A. It was discharged into a borrow pit which had been
formed in getting earth to build an embankment in 2503
which the sewer was laid for some distance above the tank.

XQ. 255. Was the material within the tank stirred up before the centrifugal pump was started? A. The material was stirred up at different times in the operation of pumping out the tank.

XQ. 256. And were the scum and sludge both 2504
removed from the tank? A. Both were removed, but of course not completely. There would still be material clinging to the sides of the tank and some left in the bottom.

XQ. 257. How often did you see the centrifugal pump at the second Champaign tank in operation? A. Probably two or three times a year; in 1898 and the first part of 1899.

XQ. 258. Are you able to state positively that you did not see the second Champaign tank cleaned out or its centrifugal pump operated in 1897? A. Yes.

2506 XQ. 259. In what way are you able to fix this fact so conclusively in your mind? A. I find in my memorandum diary of the Champaign work that the pumping machinery was installed about November 23, 1897, and that on November 27, we made modifications of connections from ejector and ran pump, and under date of December 4, this entry:

2507 "In P. M. Brower, Joe and I went to outlet and experimented on pumping machinery."

This was for the purpose of determining whether the machinery would properly operate, and no effort was made at that time to pump out the tank. If there had been any cleaning of this tank during November or December of that year, I think I should have known of it.

2508 XQ. 260. To what extent did you operate the centrifugal pump in December, 1897? A. Only so far as necessary to see that the machinery worked properly.

XQ. 261. Did you pump out as much as half of the contents of the tank at that time? A. As I
2509 remember it we pumped out only a small amount our main efforts being directed to arrange the connections for the ejector in such way that the centrifugal pump would prime. We had some difficulty in priming the pump and in getting rid of the air at the top of the pump. As I remember it only a small part of the contents were removed, not

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so much as half, for it took a long time to get out any quantity.

XQ. 262. When did you next experiment with the centrifugal pump? A. After this the operation of the machinery and the cleaning of the tank was in the hands of the city engineer, of Champaign, Mr. R. P. Brower, since deceased. So far as I know 2511
the pump was not experimented with until the time of the first cleaning of the tank which was, as I remember it, about six months after the tank was put into operation.

XQ. 263. What makes you think it was six months? A. That is given from memory. I have no notes concerning the Champaign sewerage sys- 2512
tem and tank with me after December, 1897.

XQ. 264. Who built the second Champaign tank and who ran the pumping engine or looked after its operation? A. The tank was built under my immediate direction by a force of city employees. The operation of the centrifugal pump was under the charge of the city engineer, Mr. Brower, who, when 2513
this tank was installed, took considerable interest in the operation of the tank and in the running of the machinery. I do not know who assisted on this work.

XQ. 265. You have stated, I believe, that on November 3rd and 6th, 1897, you examined the second Champaign tank. Please state what you found to 2514
be the condition of such tank as regards the character and quantity of sludge and scum? A. I do not remember very definitely concerning this. There was some scum on the top, and when we stirred the bottom of the tank on November 6th, gas was given off, which, as I have stated previously, was ignited by us.

2515 XQ. 266. In reading from the Twelfth Annual Report of the Illinois Society of Engineers and Surveyors, the paper read by you before that society in January, 1897, you have omitted certain matter that appears as part of such paper upon pages 68 and 69 of the report, from which you read. Please
2516 state what the matter omitted from your paper was, and at what points the omissions occur. A. The beginning paragraph which was the first omission is as follows:

"Sewage purification, partial or complete, has made great advances in the past few years. In the United States, especially in New England and New York, and particularly where the prevention of pollution
2517 of the water supplies by sewage is of great importance, sewage purification works have been put in operation in many cities, sometimes an enormous cost of construction and at a considerable cost for mainteance. Here in Illinois not much has been done, but that statement does not furnish evidence that sewage treatment is unnecessary. Except in those cities which are fortunately situated on large streams, the sanitary condition of the outlet
2518 of the sewers and of the stream just below is not in keeping with the present stands of civilization. This is true of most of our inland cities.

Undoubtedly great expenditures must be made in the near future to include the effluent, remove the nuisance, and preserve proper health conditions, and the smaller the water course receiving the sewage the greater the necessity for action."

2519 The following paragraph was omitted at the first line of stars:

"Fresh sewage, that is, sewage that has been carried to the outlet with a fair velocity, as would be the case where the grades and dimensions of the sewers do not admit of stop pages and deposits, has for part of tis ingredients inorganic compounds, but generally much more than one-half is organic decomposabe matter of which, roughly speaking, one-half

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is in solution and one-half in suspesion, varying according to the nature of the sewage. That in suspension, in systems having moderate grades, solids not very finely divided, either much lighter than water or having about the same specific gravity."

After the next succeeding paragraph the following was omitted:

"Writers on sewerage generally give two or three 2521
feet per second as the velocity necessary to prevent deposits in sewers. While it is desirable to get the velocities, as a matter of fact, an actual constant velocity of 1.5 feet per second will result in clean sewers, and regular velocities of one foot per second may not give bad results. Of course, the actual velocity during the ordinary flow is here meant, and not that when the sewer is flowing full or half full.
When the velocity is reduced to less than 0.5 feet 2522
per second, any of the larger solids in suspension will be separated from the sewage, the lighter floating and the heavier settling; and when the current is much less than 1.1 foot per second this action is more certain, and affects finer particles and those whose specific gravity closely approaches that of water. Time is essential to any operation, and hence the distance through which this separation
takes place will affect the results?" 2523

XQ. 267. I call your attention to the Tenth Annual Report of the Illinois Society of Engineers and Surveyors, held at Monmouth, Illinois, January 23, 24 and 25, 1895, and to a paper beginning on page 27 of said report and entitled "The Purification and Sewage by Intermittent Downward Filtration—
Prof. Arthur N. Talbot, of Champaign." Please 2524
state whether you read such paper before the Illinois Society of Engineers and Surveyors at the time mentioned and whether such paper is correctly reported; and state also whether the report of the discussion upon page 31, of said book, is correctly given? A. I read such a paper and I presume the

record of the paper itself is correct. I cannot vouch in any way for the report of the discussion as I sometimes found in the meetings of the society that statements were printed which were not as made at the time.

XQ. 268. Have you any reason to question the
2526 correctness of the statements attributed to you up-
on page 31 of this report for the year 1895? A. Yes, The amount of sewage placed upon one acre would be very large, and the construction of the filterbed as given in the reply attributed to me, must be inaccurate. For this reason I am not cer-
tain that the remainder of the quotation is correct-
2527 ly reported.

XQ. 269. In the course of your direct testimony you have referred to a discussion following a paper read by Mr. Alvord at the Thirteenth Annual Meeting of the Illinois Society of Engineers and Surveyors, and have quoted at considerable length the remarks attributed to you in the report of such dis-
2528 cussion. Please examine the report of the discus-
sion and state whether or not you find any errors in the remarks attributed to you? A. Of course I cannot remember just what was said at this meeting. I think the statement made that as high as 1,500,000 gallons per day had gone through the tank is inaccurate as I do not recall any such flow
2529 before that time. I do not believe that this report
is accurate throughout, but as my memory is my only guide, I do not wish to attempt to say in what way it was not correct.

XQ. 270. The discussion referred to contains the following:

"Mr. W. S. Shields: I would like to inquire of

Prof. Talbot what he considers the capacity of his tanks at Champaign.

Prof. Talbot: That must of course be a matter of experiment and observation. My opinion has been that the capacity might be 500,000 gallons of sewage per day of actual sewage—but that estimate is probably too high. At the present time storm water from a stream is discharged through the 2531
outfall sewer and goes through the tank. There have been as high as 1,500,000 gallons per day, but under these conditions of course the tank is not very active. I should say it would treat 200,000 gallons of sewage per day, but it may be that a larger tank would more efficiently treat such a flow."

Is it this part of the discussion which you think may perhaps be inaccurate? A. The figure of 2532
1,500,000 gallons seems to me to be an error, as I do not remember what I considered the capacity of the tank at that time. I cannot say whether the quotation is correct.

XQ. 271. Do you remember to have said anything at the Twelfth Annual Meeting of the Illinois Society of Engineers and Surveyors, either 2533
in your paper or in the discussion following it, besides what appears in the printed report of said meeting? A. I remember that either in the discussion of the paper or in conversation with members of the society I discussed the question of changes going on in the sewage, but I am not able to say that this took place in the discussion. 2534
It was a matter about which I did not then have very full information, and I presume little was said about it.

XQ. 272. I call your attention to the proceedings of the Illinois Society of Engineers and Surveyors at its Fourteenth Annual Meeting, held

at Champaign, Illinois, January 25, 26 and 27, 1899, and particularly to the paper entitled "The Working of the Septic Tank of the Champaign Sewerage System," and the discussion following said paper. Please state whether or not the paper was read by you and whether in the
2536 printed report of the discussion following the paper your remarks are reported with substantial accuracy? A. I read the paper at that meeting. The remarks quoted on page 126 as made by me were called to my attention soon after the printed report came out. I then stated, and still think, that I did not make the remark as given
2537 there. In the same way I do not think the remark attributed to me on page 127 concerning the proper size and capacity of tank is correct.

XQ. 273. In the report of the 1899 meeting of the Illinois Society of Engineers and Surveyors I find on page 126 the following:

DISCUSSION.

2538 Present A. D. Thompson: Is this the only tank of the kind in operation in the United States?

Prof. A. N. Talbot: There have been tanks in operation which involved this principle, but they were used to exclude the sludge without any idea of bacterial purification of the sewage in the tank. The one constructed in Urbana in 1894, under my supervision, was for that purpose, but it was soon found that another action was going on. . . . .

2539 Mr. Jacob A. Harmon: I wish to ask Prof. Talbot if he has studied the species of bacteria which are active in this septic tank, and also what subsequent purification might be most effective if needed.

Prof. Talbot: Neither of those things have been done? We hope to find what the species of bacteria coming into that tank are, and we may want to transplant them.

Mr. H. G. Paddock: I would like to ask Prof. Talbot how he estimated what the capacity of the tank should be.

Prof. Talbot: This whole matter of septic tank is a new one, and so far as I know there is little known as to what the capacity should be. The idea of the engineers in England who have designed these tanks, is that they should have a volume 2541
equal to the flow of sewage for twelve to twenty hours, if I remember right.. This tank has a capacity of flow for sewage for about one hour. Now, whether there would have to be a different relative capacity for diluted sewage and for strong sewage; whether they would work better when the water is running through verly slowly or not, of course would be a question worth studying.

It is to the above quoted matter, or a part of 2542
it, I suppose, that your criticism as to accuracy is directed? A. Yes.

XQ. 274. I call your attention to the discussion appearing upon pages 223 and 224 of the Seventeenth Annual Report of the Illinois Society of Engineers and Surveyors, held at Joliet, Illinois, January 23 and 24, 1902, and ask you to 2543
state whether or not the remarks attributed to you in such published report upon the pages noted are given with substantial correctness? A. I do not remember this discussion. It has entirely passed out of my mind.

XQ. 275. Have you any reason to question the accuracy of such report? A. It does not 2544
sound at all like my wording, other than that I cannot say that I did not make the statements here reported.

XQ. 276. I call your attention to volume 7, No. 2, of the Journal of the Western Society of Engineers, April, 1902, and particularly to the

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discussion following a paper entitled "Sewage Purification Plants," said discussion beginning on page 134, and extending to page 144, and I ask you to state after reading said discussion whether you have any reason to question the accuracy of the report of the remarks attributed
2546 to you in such discussion. A. I remember that there was some mix-up in the report of the discussion, and that I did not have the opportunity to revise it, or that it was not revised. The colloquy with Mr. Alvord was an attempt on my part to bring out the ideas expressed in my paper read before the society in December, 1900. So
2547 far as the report agrees with the paper then given and which was referred to in my direct testimony, I think that this discussion is correct. So far as the rest of it is concerned I cannot now say, but I presume that most of it is correct.

XQ. 277. Do you see any particular part of the discussion the accuracy of which you wish
2548 to criticise? A. Only that given concerning the area of the tank as a measure of the capacity of the tank, and this insofar as it does not agree or gives a different impression from that in the paper in the Journal of the Society for December, 1900.

XQ. 278. Did you read the paper appearing
2549 in Volume 5, No. 6, of the Journal of the Western Society of Engineers, December, 1900, on pages 543 to 560, inclusive, and are the remarks attributed to you in the printed report of the discussion on pages 560 to 565 of said journal reported with substantial accuracy? A. Yes, so far as I remember.

XQ. 279. Have you ever published or caused
to be published any other papers, description or
written matter concerning the Urbana or Cham-
paign tanks? I mean papers other than those
which have been mentioned in the course of your
deposition? A. The only other paper which I
now recall was published in Engineering News, 2551
August 17, 1899.

XQ. 280. Did you ever give to anyone or pub-
lish any description of the Urbana or Champaign
tank other than those mentioned in the publica-
tions to which reference has been made in the
foregoing examination? A. No other printed
description, so far as I now recall. 2552

XQ. 281. What about written descriptions?
A. I presume I have given written descriptions
of these tanks at different times, but I do not re-
member when or to whom?

XQ. 282. Were the two tanks that con-
stituted what you have referred to as the second
Champaign tank used together or singly? A. 2553
They were ordinarily used together, though oc-
casionally one was thrown out of use for a short
time, as I recall it.

XQ. 283. When do you recall one of these
tanks being thrown out of use for the first time?
A. I have no definite recollection about that, and
I do not know how it came to be so used unless 2554
the city engineer wished to study the action of
the tank under such conditions.

XQ. 284. Was one of the tanks thrown out
of use before you were consulted in regard to it?
A. I had nothing to do with the operation of the
tank after the tank was put into service, and I

would not be consulted concerning the management of the tank.

XQ. 285. And you don't recall how often you saw the system operating with one tank in service, do you? A. No.

XQ. 286. When did you first see or hear or
2556 know of the term "septic tank" or "septic process?" A. The first I heard of the term "septic tank" and of the term "septic action" as applied to sewage was in the Engineering News, which contained the description of the Exeter tank. This was in January, 1898.

XQ. 287. But prior to January, 1898, you had
2557 not seen or known of the term "septic" being applied to a tank for use in a sewerage system. Is that correct? A. So far as I remember.

XQ. 288. Do you remember what your impression was when you first saw the term "septic" as used in connection with sewage disposal? A. While the tank described was different from
2558 the tanks at Champaign and Urbana in some respects, and particularly in that the tanks were absolutely air tight and dark, it struck me that the action going on was the same and that the processes were very similar.

XQ. 289. But if I understand you correctly, you never knew of the term "septic" being used
2559 to describe a sewage disposal tank prior to January, 1898. Is that correct? A. It is, and I so stated in the direct examination.

XQ. 290. In the course of your examination you have referred to a memorandum book containing memoranda with reference to the Champaign sewerage system. Will you please read

from such memorandum book the items under
date of October 2, 1897. A. The item reads as
follows:

"B. and I inspected outlet, sep. tank, inlet at
Scott park, and investigated extra flow of water.
At 171, at 1:30 P. M. depth 6 inches; at 3:30 P. M.
depth 4 inches; maximum flow perhaps 600,000; 2561
regular flow 150 to 200,000. Flow at outlet clear
at 2 P. M., and black at 2:15 P. M. Extra flow con-
tinued 30 M. to 45 M. Sep. tank finished in good
condition."

XQ. 291. Did the abbreviation "Sep." re-
fer to separating or septic as used in the above
quotation, and do the measurements referred to
in said memorandum accurately state measure- 2562
ments made by you at the time? A. The abbre-
viation refers to separating tank as it was named
in the ordinance. Both this term and settling
tank are used in this memorandum book for the
name of the tank. The flow mentioned which
caused us considerable concern until we found
the source of it was principally a discharge from
the Illinois Central Roundhouse which came 2563
through a pipe whose connection we had no
knowledge of.

XQ. 292. What was the character of the sub-
soil through which the sewers leading to the Ur-
bana tank and the first Champaign tank ex-
tended? A. Principally clay, although there was 2564
some sand.

XQ. 293. Have you ever filed any applica-
tions for patents with respect to a tank for sew-
age disposal. A. No, I have never made any
applications for patents in any line.

Re-Direct Examination by Mr. Banning.

R. D. Q. 294. Where was the Urbana tank,

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constructed in 1894, located with reference to the stream called Boneyard Branch? A. It was located near a small creek having the name "Salt Fork" something like a quarter of a mile below the point where Boneyard Branch discharges into it.

2566 R. D. Q. 295. Was the whole stream sometimes called Boneyard Branch? A. It is possible that some people called this creek Boneyard Branch, but that name should be restricted to the tributary of this creek.

R. D. Q. 296. If you have any other memoranda here present with reference to the con-
2567 struction of that Urbana tank, please be kind
enough to produce the same and read therefrom such portions as you may consider material, especially with reference to the tank itself. A. I have here the bills of the Dubuque Construction Company for extra work in connection with the Urbana sewerage system. These bills were sub-
2568 mitted to the counsel here present during the
cross-examination. It contains an item of one hundred dollars for building the settling tank, together with some other items for work on that. The date of the items on the bill relating to the tank are 1894, and under the heading November:

2569 "November 23, man and team, scraping one-half day.................... $1 50
November 23, man eight hours cutting ditch .... 1 20"

Then follows a total of $39.53. Then an item: "Building cetling tank............... 100 00" followed with a total of $139.53.

R. D. Q. 297. If you have here present any ordinance passed by the city council of the city of

Urbana relating to the purchase of land, to be used in connection with that tank built in 1894, please produce the same. A. I produce a printed copy of an ordinance "To Provide for the Construction and Maintenance of Certain Lines of Sewerage Therein Named in the City of Urbana, and to Provide for the Purchase of Ground for 2571
Outlet to the Same and to Pay for Such Improvement by General and Special Taxation," passed July 3, 1894, and approved July 3, 1894.

Counsel for defendants offers in evidence the bill of the Dubuque Construction Company produced and identified by the witness in his answer to Re-Direct 2572
question 296; and the same is marked "Defendants' Exhibit Dubuque Company Bill."

Counsel for defendants also offers in evidence the ordinance produced by the witness and referred to in his answer to Re-Direct question 297; and the same is 2573
marked "Defendants' Exhibit Ordinance No. 3."

It is stipulated that no proof need be introduced by either party in reference to the publication of the various journals, magazines and papers referred to in the foregoing examination of Prof. Talbot; and that either party shall be 2574
at liberty to produce any or all of such journals, magazines and papers at the hearing of this cause and use the same for any proper purpose subject to objections in reference to materiality and competency. ARTHUR N. TALBOT.

Adjourned until Wednesday, August 9, at 10 o'clock A. M.

2575 JOHN C. F. SELL.

John C. F. Sell, a witness, produced, sworn and examined on the part of defendants, deposes and testifies as follows, in answer to questions by Mr. Banning:

Q. 1. Please state your name, age, residence and occupation. A. John C. F. Sell, 58 years,
2576 Urbana, Illinois, street superintendent.

Q. 2. When did you first become street superintendent of Urbana and how long have you been such superintendent? A. From '83 to '89, the first time I was street superintendent. And from 1893 to 1897, the second time, and since the 15th day of last May the last time.

2577 Q. 3. What have you had to do as street superintendent of Urbana with reference to the removal of sewerage or apparatus used for that purpose? A. I have had charge of that work.

Q. 4. Was any special apparatus or tank ever built at Urbana for the disposal of sewage while you were street superintendent there? A. Yes,
2578 this tank was built.

Q. 5. What tank do you refer to and where was it located? A. Well, it was built for cleaning out the sewers. The tank was northeast of Urbana, about half a mile from the court house.

Q. 6. What was it connected with? A. It was connected with a 12-inch sewer pipe at the end
2579 of the sewer.

Q. 7. Was it close to any creek? A. Yes, sir; it was two or three rods from the creek—Boneyard Branch.

Q. 8. How large was that tank? A. I could not say exactly to an inch. I judge it was 5 feet wide inside and I think it was 22 feet long, and

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I think it was between four and five deep to my
recollection.

Q. 9. Of what material was it constructed?
A. It was constructed of brick—brick wall
around. I think the bottom was concrete.

Q. 10. Was it covered? A. Yes, sir.

Q. 11. What with and who put the cover on? 2581
A. It was covered with 6 by 8 sill. It ran on
the wall all the way around, and a two-inch cover
put on the top of it, two-inch plank. I think I
put the cover on or worked on it. There was a
man there to do it and I was there myself.

Q. 12. How tight was that cover and how
tight did it make tank? A. Well, the cover 2582
lay right on top of the sills. There were no
cracks between the planks. I think they were
tongued and grooved lumber.

Q. 13. When was that tank built, as near as
you recollect? A. I think in 1894. The fall of
'94.

Q. 14. When was the cover put on, before or 2583
after the sewer was opened and the tank put into
use? A. Well, I think the sewer had been in
operation either in October or November in the
fall of '94, and the cover put on about the same
time when the tank was ready for use.

Q. 15. The cover was the last part of the
work of the tank, I suppose? A. Yes, sir. 2584

Q. 16. Did you put any baffle boards into that
tank? A. Yes, sir.

Q. 17. When were they put in and how? A.
The same time the lid was put on. They extended
crosswise.

Q. 18. How far did they go into the water

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when the tank was full? A. Oh, about a foot. I can't tell exactly to an inch. The bottom of the baffle board was about a foot above the bottom of the tank. I can't just get on to it straight, but I think that's the way it was.

Q. 19. Then was the baffle board so arranged
2586 that the water ran under it? A. Yes, sir.

Q. 20. Did you ever have anything to do with the cleaning out of that tank? A. Yes, sir.

Q. 21. When was it cleaned the first time as near as you can remember? A. The spring following after it was put in. I think it was in March or April the first time.

2587 Q. 22. Did you clean it personally? A. Yes.

Q. 23. How? A. Had a wagon there and a tight box, pump on top of the box, and a hose on the pump leading into the tank, and by hand pumped it out into the wagon box.

Q. 24. What did you pump out of it, particularly the first time yon cleaned it? A. Pumped
2588 out it was not very heavy, it was heavy enough to get all mixed up of course when stirred it up, pumped out the heavy stuff.

Q. 25. Did you pump out much solid matter, or most liquid? A. The water of course makes it thinner so as to be easily to pump. There was no solid matter after the pump was gone; it was all stirred
2589 up, no heavy stuff at all hardly.

Q. 26. How often was that tank cleaned after that? A. Every two or three months.

Q. 27. In the same way? A. Yes, sir, the same way each time.

Q. 28. What did you get out of it each time? A. Pretty near the same each time.

JOHN C. F. SELL. 2590

Q. 29. Where was the matter put or what was
done with it after you took it out? A. Put it out
in the pasture. There was a pasture close by.

Q. 30. What became of it and particularly what
was the appearance where you put it? A. You
could hardly see anything after two or three hours.
You could hardly see where it was put. There 2591
was one day after it was cleaned out I just thought
I would go there and see what it looked like. I
couldn't hardly see anything on the ground.

Q. 31. What kind of an odor or smell did it give
off? There was hardly any smell to it, except when
you opened up the lid and stirred it up the smell
was kind of strong. That is all I noticed. 2592

Q. 32. How did you find it with reference to
pumping. Was it hard or easy to pump out? A.
Oh, it was not so very hard to pump. If it was
everything in good shape it was easy to pump.
Sometimes they put in heavy paper and that sticked
in the pump and you can't pump it.

Q. 33. Did you find the odor or smell about what
you expected it to be or different? A. I expected 2593
it would be stronger.

Q. 34. How long was that tank used in the way
you have described. A. From '94 until now, about
two weeks ago. Well I could almost state the date
when it was disconnected. I think it was about
in the neighborhood of the 25th or 26th of July
that it was disconnected. It was about two weeks 2594
ago, that is they disconnected the old one into the
new septic tank.

Q. 35. Did that tank put in in the fall of 1894
do the work right along that it was intended to do?
A. I never heard anything different. There was
no trouble that I heard.

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Q. 36. Did it work satisfactorily? A. Yes, sir.

Q. 37. Was it used publicly so that anybody interested could see it or know about it? A. Yes, the lid was right on top of the ground, and it was locked—it was that way the first four years, I don't know how they done it afterwards. That is the
2596 way it was made.

Q. 38. Why was the lid locked down? A. Well that nobody could get to it and throw anything in there. They keep it locked. That is I mean not get the lid open.

Q. 39. Did that locking down of the lid make it a tight tank? A. Made it tight.

2597 Cross-examination by Mr. Fisher.

XQ. 40. Do you mean to say Mr. Sell, that the tank worked in the same way and just as satisfactorily since May of 1905, as it did from the time it was put in in 1894 until 1896? A. Yes, sir, I don't know anything different. I never heard any complaint.

2598 XQ. 41. Everything seemed to be working in the tank since May of this year until the tank was taken out in the same way as it did when you examined the tank in the winter and spring of 1895. Is that correct? A. Yes.

XQ. 42. How often have you cleaned out the
2599 tank since the first of May, 1905? A. Not at all.

XQ. 43. When was the cover taken off the Urbana tank? A. It is there yet.

XQ. 44. When did you see it last? A. I didn't see the inside of it, I saw the outside. I didn't see the inside for seven or eight years. I did not have anything to do with it.

XQ. 45. When were you last at the Urbana tank? A. About two or three weeks ago.

XQ. 46. Is that as near as you can fix the date? A. Well I was around there but I was not at the tank exactly. I didn't have the lid open for the last seven or eight years. I was right close by there about a week ago. That is when I disconnected 2601
from the old to the new.

XQ. 47. Was the lid on the old tank at that time? A. Yes, sir.

XQ. 48. Was the old tank in good condition at that time? A. I guess so, so far as I know.

XQ. 49. Who had the key to the lock that held the lid on the old tank? A. I carried it for a 2602
while. I don't know if I always had it. I think I did. It is seven or eight years ago. It is quite a while back. A person can't remember exactly.

XQ. 50. Did you ever let anybody else take that key? A. Not that I know of.

XQ. 51. Was the tank locked from the time it began operation until you served out your first term 2603
of office as street superintendent, I mean until 1897. A. I think it was.

XQ. 52. And you carried the key during that time, did you? A. Yes, sir.

XQ. 53. According to your best recollection you did not let anyone take the key at that time? A. No, sir. 2604

XQ. 54. Was there only one key to that tank cover? A. I think there was only one.

XQ. 55. How much did you have to pay for cleaning out that tank? A. I think at first we paid five dollars for it, and then they wanted more and I guess they got more.

XQ. 56. Who got paid for cleaning out the tank?
A. Differenet parties. But mostly when I had
charge of it Mr. Jim Haney cleaned it.

XQ. 57. Who else besides Jim Haney cleaned
the tank between 1894 annd 1897? A. I think he
done all so far as I can remember.

2606 XQ. 58. When the tank was to be cleaned who
gave the order for it to be cleaned? A. Well I
generally went over there and see if it was neces-
sary and then I told the sewerage committee that
it ought to be cleaned out and then I hired a man
and had it done.

XQ. 59. Did you unlock the tank so the man
2607 could clean it out? A. I did.

XQ. 60. How did you decide or decermine how
often it was necessary to clean out the tank? A.
I done that of my own judgment. When there was
ten inches or a foot of sediment on the bottom then
I cleaned it out.

XQ. 61. But you only allowed the tank to be
2608 cleaned out when you found that there was prob-
ably a foot or ten inches on the bottom? A. I
would not say that exactly. When I saw there was
sediment enough on the bottom that was worth
while to clean it out why I done it. At different
times of year when it needs it more often than other
times. Starting from September to June the time
2609 the students were in the college it was more used,
mean when the college opened and closed again.

XQ. 62. You mean that the tank was put to
greater use from September when the college began
its school year until June when the school year
closed, than it was put to during the summer, is
that correct? A. Yes.

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XQ. 63. And you caused the tank to be cleaned oftener during the college year than during the summer did you not? A. Yes, sir.

XQ. 64. How often did you cause the tank to be cleaned during the Summer time? A. I couldn't say that. Maybe once between time from June to
September, I think that's it. 2611

XQ. 65. About how much oftener was it cleaned after the school began its session in September? A. I couldn't say that exactly.

XQ. 66. Did you find a heavier deposit of sediment in the tank soon after the school began its session in September? A. Yes, sir, I did; it was
used more. 2612

XQ. 67. What was the nature or consistency of this sediment which you say you found in the bottom of that tank after the school met in September? A. Well it was all kind, all mixed up.

XQ. 68. When you opened the tank to examine its contents did you notice anything on the surface
of the sewage? A. I did. 2613

XQ. 69. What did you see there? A. Kind of a scum on top of it, and below it was water down to the sediment.

XQ. 70. Was the sediment thick enough on the bottom of the tank for you to tell when it was ten or twelves inches deep and when the tank ought to
be cleaned? A. Yes I could tell it with a stick. 2614

XQ. 71. How could you tell it by the stick?. A. I could tell it easy by dipping the stick through the water and when it got down to the solid substance —not solid either—I could feel it. I could just barely feel it so as to tell it was something else than water.

XQ. 72. Was the sediment on the bottom of the tank hard enough or solid enough so that when you ran the stick down you could feel it go down through the sediment? A. Don't need to bear your stick at all it would just go through easy.

XQ. 73. Would the sediment make a mark on
2616 the stick? A. No, sir, not that I remember.

XQ. 74. How were you able to tell whether the sediment was ten inches deep or twelve inches deep? A. That is easy enough. When you get your stick down to it. Of course I never measured it.

XQ. 75. Who paid for cleaning out the tank? A. The city did. The pays comes out of the city
2617 funds.

XQ. 76. Did the parties who cleaned the tank always get a receipted bill for the work. A. I don't know the pay roll show it, the montly pay roll of the city council.

XQ. 77.. When the tank was being cleaned out how many men assisted in the operation? A. Gen-
2618 erally took two.

XQ. 78. Who were these men? A. Mr. Haney was one of them, the most I hired, and he generally had his boy with him most of the time. Sometimes he did it alone.

XQ. 79. How long did it take Haney to clean out the tank when he had a boy to help him? A.
2619 The boy couldn't help, the second man couldn't help very much. I took generally a day.

XQ. 80. Did you allow the sewage to run into the tank while it was being cleaned out? A. It generally did. I don't know how we closed it up. I think there was a side sewer when we cleaned it out. I can't tell it exactly, I think there was a side sewer that ran into the creek. I think that is the way it was.

XQ. 81. But you are not sure whether you shut off the sewage from the tank while it was being cleaned or not, are you? A. I can't answer that question exactly.

XQ. 82. Was there ever anybody present at the 2621 time this tank was being cleaned out besides yourself and Haney and his boy? A. Oh, you would probably find some loafers there standing around for a while.

XQ. 83. Did you ever seen Prof. Talbot there while the tank was being cleaned out? A. I think he's been there once or twice according to my recol- 2622 lection when the tank was being cleaned out.

XQ. 84. Have you examined the books or pay rolls of the city council of Urbana in order to tell how often the tank was cleaned out from 1894 to 1897? A. Yes, I always made out the pay rolls.

XQ. 85. Have you recently examined the pay rolls from the year 1894 to the year 1897 for 2623 the purpose of ascertaining therefrom how often the tank was cleaned out during such period? A. No, sir.

XQ. 86. When did you last examine the pay rolls for the period from 1894 to 1897? A. I made out the pay roll at the time and handed it to the city council and never saw it afterwards. 2624

XQ. 87. I suppose you were testifying entirely from memory as to how often the Urbana tank was cleaned out. Is that correct? A. As near as I can to my knowledge, but it is from memory merely.

XQ. 88. In what way if at all have you endeavored to refresh your memory as to the times when the tank was cleaned out? A. Hardly any. I didn't have any time to refresh my memory.

XQ. 89. When were you first asked if you remembered how often the Urbana tank was
2626 cleaned out? A. I don't believe I was asked that question.

XQ. 90. Who requested you to come here and testify? A. Prof. Talbot.

XQ. 91. When did he first speak to you about coming here and when did he first ask you what you remembered about the bank being cleaned
2627 out? A. Oh, it's about a week ago.

XQ. 92. What did he say to you about that time? A. He did not hardly say anything. He was talking the matter over and I told him the same thing what I said here. Could not tell it any different.

XQ. 93. Did Prof. Talbot tell you that he
2628 had advised that the tank should be cleaned out once a month? A. I couldn't say that. I don't know whether he did or not.

XQ. 94. Did you understand from your conversation with Prof. Talbot that he wished to prove by you that the tank was not cleaned out very often? A. No, sir, he never said that.

2629 XQ. 95. State as nearly as you can recall just what the conversation was between you and Mr. Talbot. A. Just about what I testified. I can't remember.

XQ. 96. Did you understand from him that he wished to prove by you that the tank was only cleaned out three or four times a year? A. Well, I don't know if he did or not.

XQ. 97. But you understood from his conversation, did you not, that he was anxious to prove that the tank was not cleaned out very often? A. Well, I don't know if he did or not. Of course when I first talked to Prof. Talbot he never said that I was to testify that I was to come up here. I
had no idea that I was to come up here. We just 2631
talked the matter over how the tank was working.

XQ. 98. And did he tell you how often he thought the tank should be cleaned out? A. No, he did not give any orders how often.

XQ. 99. At the time you were street superintendent from '94 to '95, did not Prof. Talbot tell you
or indicate in some way to you how often the tank 2632
should be cleaned out? A. May be he did. That is a long way back. I won't testify to that at all.

XQ. 100. How many interviews did you have with Prof. Talbot in regard to this tank within the last month or two? A. Two.

XQ. 101. Have you talked with anyone else 2633
about this tank? A. No, sir.

XQ. 102. At either of the interviews with Prof. Talbot did he not tell you that he wished to prove by you that the tank was not cleaned out very often? A. No, sir he did not say anything like that. He just told me I should tell what I know
about it, as near as I can. 2634

XQ. 103. You remember anything about the construction of the inside of the tank of Urbana? A. I gave that before.

XQ. 104. Did the tank have inside of it more than one baffle board. A. It had a cross wall in the center.

XQ. 105. But did it have more than one wooden baffle board? A. One on each end.

XQ. 106. How far from each end? A. About three feet I should judge.

XQ. 107. When you talked with Prof. Talbot recently, did he show you any sketches of the Ur-
2636 bana tank? A. I don't beleive he did—No.

XQ. 108. How far was it from the baffle board adjacent the outlet opening to the outlet opening or pipe that carried the liquid from the tank? A. I don't know. I said it was three feet.

XQ. 109. Was there anything between the outlet hole or pipe at the end of the tank and the
2637 baffle board? A. It is open underneath, under the baffle board.

XQ. 108. (a) Was there anything between the baffle board and the discharge pipe at the end of the tank? A. Not as I know Not as I remember.

XQ. 109. (a) How deep was the tank at the opening through which the fluid was discharged
2638 —I mean the hole in the wall through which the drain pipe took the sewage away from the tank? A. I can't tell that exactly. I know the tank was between four and five feet deep.

XQ. 110. But how deep was the part of the tank at the pipe it led from the tank to the creek? A. I couldn't answer that.

2639 XQ. 111. Did you never examine the discharge end of the tank? I don't know if I did.

XQ. 112. Did the discharge pipe from the tank lead into the bed of the stream? A. I guess it did.

XQ. 113. And did it discharge underneath the surface of the water of the stream? A. I don't think it did. I couldn't tell.

XQ. 114. I suppose you never noticed anything
running out of that pipe did you? A. Not much.
It was in the bed of the creek in the water.

XQ. 115. What was there at the receiving end
of the tank? I mean how wae the sewer pipe con-
nected to the receiving end of the tank? A. The
pipe was walled into the brick wall, as near as I 2641
can remember. I did not have time to freshen up
my memory.

XQ. 116. Did the sewer pipe extend any dis-
tance into the tank beyond the inner face of the
wall? A. I couldn't tell you, I have forgotten
that.

XQ. 117. Was there any valve or gate inside 2642
the tank or adjacent to the tank, so far as you re-
member? A. I don't know that either. I know
it worked all right. That is all I can tell you.

XQ. 118. Did you ever stir up the material in
the tank? A. I don't know if I did.

XQ. 119. I mean did you ever stir up the ma-
terial and flush out the tank so as to save the ex- 2643
pense of cleaning it so often? A. I guess not.
It was not necessary to do. I just pumped it out
and it was cleaned afterward.

XQ. 120. But did you not sometime stir up the
tank to see what the conditions was and determine
whether it ought to be cleaned out or not? A.
Only time I went there was when I thought it was 2644
about time to clean it out. I didn't bother between
time.

XQ. 121. Was there much odor about the tank?
A. No, sir. You could hardly tell. When you
come there you could hardly tell there was such a
thing there. When you opened the lid was the only
time it smelled strong, not so very strong either.

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XQ. 122. How often did you visit the tank between the Fall of 1894 and 1897? A. I couldn't tell that. I didn't make any note of it at all.

XQ. 123. Did you always order it to be cleaned out when you went there and examined it? A. When I thought it was about time to clean it out
2646 I went to the sewerage committee and told them about it, and then I went to work and cleaned it out.

XQ. 124. But as I understand your testimony, you only visited the tank when you thought it was about time to clean it out, is that correct? A. Yes, I had no other business there.

2647 XQ. 125. Did you ever go down to the outlet of the sewer pipe at the creek and examine the liquid that was flowing from the tank? A. I never did. I went right close by the tank.

XQ. 126. Who cleaned out the tank between 1897 and May, 1905? A. I couldn't tell you.

XQ. 127. And of course you don't know how
2648 often it has been cleaned out since 1897? A. I couldn't tell you that.

XQ. 128. Did you examine the inside of the tank between 1897 and May, 1905? A. No, sir.

XQ. 129. Did you ever notice whether there was any scum on the tank between the baffle board and the discharge hole or pipe in the end wall of
2649 the tank? A. I could not answer that.

XQ. 130. Did you ever take off the scum to see how thick or heavy it was? A. I should judge it was about as thick as my finger, about an inch thick. I should judge it was.

XQ. 131. And was this scum continuous all over the surface of the tank? A. Pretty near.

XQ. 132. State what the scum looked like? A. It wasn't very smooth. It was like putting a heavy carpet over.

XQ. 133. Were there any holes in the scum? A. I couldn't tell that.

XQ. 134. Wasn't there a cross wall or partition in the tank between the baffle board and the outlet 2651
hole. A. There was a brick wall in the center of the tank.

XQ. 135. But wasn't there any other wall between the baffle board and the outlet hole of the tank? A. I don't think there was.

J. C. F. SELL.

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2655 WILLIAM S. MACHARG.

August 9, 1905; met pursuant to adjournment; present as before.

William S. MacHarg, a witness produced, sworn and examined on the part of defendants, deposes and testifies as follows, in answer to
2656 questions by Mr. Banning:

Q. 1. Please state your name, age, residence and occupation. A. William S. MacHarg, 57 years old, Chicago, a civil engineer. The class of engineering work to which I give special attention is that of water works and sewerage, commonly called sanitary engineering. I am a mem-
2657 ber of the American Society of civil engineers.

Q. 2. Please state fully what experience you have had as an engineer, particularly in sanitary engineering. A. I commenced in 1869 after graduating as mining engineer from Michigan University, in the office of Mr. E. S. Chesbrough, at that time city engineer of Chicago. I followed
2658 the profession generally since being in this city with the exception of two years, in '71, '72 and '73, when I was connected with the sewerage department of New Haven, Connecticut. Afterward, from '73 to '79, I was connected with the sewerage and water department of the city of Chicago. From 1879 to 1890 I practiced my pro-
2659 fession here in the city. In 1890 I was appointed engineer of water supply sewerage and fire protection of the World's Columbian Exposition, and designed, constructed and operated the water works and sewerage works of the Exposition, finishing in November, 1893. I afterwards practiced my profession here in the city and in 1897

was appointed consulting engineer on intersepting sewers of the sewerage department of the city of Chicago, which position I now hold and have since that time.

Q. 3. What have you had to do with reference to apparatus for sewage disposal? A. During the years subsequent to 1884 I have put in a number of plants for the treatment and disposal of 2661
sewage. The first o f these were of the type which was introduced, so far as my knowledge goes, into this country, by Colonel Waring. This system was called by the general name of sub-surface irrigation. It involved the use of two tanks, or a tank divided into two sections, one of which 2662
received sewage and held a constant quantity overflowing into a second basin or compartment in which was set an automatic flushing siphon which, when second basin or section became filled to a certain height, automatically discharged the sewage into a series of vitrified or hard burned tile laid with open joints immediately below the 2663
surface of the ground, preferably laid in the upper ten inches of the soil, in which ground the purifying process was completed, the escaping fluid or effluent being inoccuous.

In addition to this I applied a similar system on a much larger scale in which the tank was used in connection with intermittent filtration 2664
in the year 1885 and again in 1889. I subsequently put in plants in which sewage was treated by intermittent filtration about the year 1892, at Soldiers' Home, in Quincy, and the Soldiers' Home, Milwaukee, Wisconsin, in or about 1894; and in or about the same year 1892,

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I built a plant for the Rochester Insane Hospital, at Rochester, Minnesota, using the ordinary process of intermittent filtration, but providing a series of tanks to be used, if necessary, during severe winter weather for chemical treatment. In 1892 and '93 I designed and built and operated
2666 the purifying or cleansing plant for the sewage of the World's Columbian Exposition. This plant was a chemical plant, the object being to clarify rather than to carry to a high degree of purification. The most recent plant put in by me is at West Allis, Wisconsin, and was built in or about 1903. In this plant a septic tank is used followed
2667 by an anaerobic filter with a percolating filter as the finishing process.

Q. 4. Did you ever construct any sewage disposal plant for the St. Joseph Orphan Asylum of Chicago. A. Yes, sir.

Q. 5. When did you construct that plant and how was it constructed? If you had previously con-
2668 structed any similar plant, or plans operating on the same general principle, you may refer to and describe the same, particularly in leading up to your work at the St. Joseph Orphan Asylum. A. I did construct such a system at St. Joseph Orphan Asylum in the year 1889, but had previously constructed at the Altenheim or German Old People's
2669 Home of Chicago, a plant which was the forerunner and very largely the same as the plant constructed at the St. Joseph Orphan Asylum. The Altenheim is a building located near West Madison Street continued, and within a few hundred feet of the Desplains River, just west of the City of Chicago. The system installed there involved

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the use of a large tank, about 8 feet in diameter and 30 or 32 feet in length, built in the ground at such depth as to receive the sewage discharged from the buildings which form this home and its operating departments. The sewage received into this tank, the tank being divided at or near the middle by a dam rising well above the springing 2671
line of the upper arch of the tank, with a baffle set immediately behind the dam and carried down below the spring line, both the dam and the baffle being built as was the tank, of brick masonry, the sewage, as I stated, being received in this tank behind the dam, was held to allow the liquefaction of the organic solids contained there- 2672
in by bacterial action; and the condition was that of a secluded pool of sewage with a nondisturbing inlet, and a nondisturbing outlet, and the operation was the flow of sewage continuously or intermittently as it came from the buildings, but being practically a continuous flow the discharge over the dam accumulating in the second section of the tank 2673
from which at convenient intervals, at least daily, it was pumped up and distributed through a hose to a filtering area prepared by underdraining so as to present the proper condition for the aeration and final stage in the purification of the sewage.

Complainant's counsel objects to the matter set forth in the foregoing answer, 2674
for the reason; First, that the matter has not been pleaded or set up in defendants' answer; and, Second, for the reason that it is incompetent and not the best evidence, concerning the tanks referred to by the witness.

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Q. 6. If you have any drawings or description
of that plant at the Altenheim, will you be kind
enough to produce and identify the same, making
such explanations as you consider necessary? A.
I had of course the original drawings at the time
the work was designed by me and constructed;
2676 these however, are now lost and I have obtained
from the architect of the Altenheim a drawing
which shows the system and was one of the draw-
ings made at the time the work was constructed.
The architects were Messrs. Bauer & Hill, of this
city, and Mr. Hill of that firm is now connected
with the firm of Hill & Woltersdorf. I present the
2677 plan of which a tracing may be made, but the plan
I must return to Mr. Hill. For convenience of ref-
erence I mark the following letters upon the draw-
ing: A is the principal building of the Altenheim;
B is a building containing the offices, laundry, etc.;
C is the tank which received the sewage and in
which the sewage was dissolved; D D is the under-
2678 drain area used for final disposition of the sewage;
The scale of the plan is 32 feet to the inch. The
sewage from the building was received from the
sewers indicated on the plan by lines running to
and connected with the end of the tank. The tank
is in sectional plan with the two divisions baffled
and dam indicated by lines across the plan. The
2679 sewage was pumped from the opposite end of the
tank as before described into a tank set above the
ground to which the hose could be conveniently at-
tached and through this hose the sewage was spray-
ed or run upon the ground of different parts of the
filtration area. The area was underdrained as be-
fore stated and lines of underdrain are shown upon

the plan leading to a lake or a pond which is indicated by the letter E which I now mark thereon. From this pond an overflow pipe was carried as shown, which ran directly to the Des Plaines River, which overflow is marked by me F. So far as I know it is constructed as shown on the drawings, that is to say there is no reason why there should 2681
be any variation from the drawing, which agrees with my memory.

> Same objection as to the last answer.
>
> Counsel for defendants offers the drawing produced by the witness in evidence, and it is stipulated that subject to the foregoing objection a tracing thereof may 2682
> be used instead of the original, and such tracing is marked "Defendants' Exhibit, Altenheim Plant."

Q. 7. Please state just when that Atenheim plant was constructed, and put into use, how long it was used, how it operated, particularly with reference
to solids in the sewage, and any special facts or cir- 2683
cumstances relating to its construction or operation which you know of—answering fully.

> Last objection repeated; and it is agreed, to avoid repetition, that the objection may be understood as if made to all questions and answers relating to the 2684
> Altenheim system.

A. I can only answer of my own knowledge as to the time that this work was constructed. It was in the Summer of the year 1885. I know it, because I did the work at that time, and while the building was being constructed and the date of the

erection of the building is on the building. I never saw this plant operated. This plant is intended and designed to operate to dissolve the sewage received into the first compartment by bacterial action, and the condition necessary to facilitate the development and action of the bacteria in liquefy-
2686 ing the solids or organic matter of the sewage are combined and used in the design and construction of this tank, the condition being the exclusion of air and light and the prevention of serious agitation. These conditions being such as to facilitate the rapid development and action of the bacteria. The sewage flowing into the large body of sewage
2687 retained behind the dam produces practically no disturbance, the outlet built in a common and usual form offers the passage under the baffle of the full width of the tank at the point where the baffle joins it, and the water flows over the dam under the same conditions, namely: that the dam is the full width of the tank at the point of connec-
2688 tion of its upper surface, allowing a very thin sheet of sewage to flow over it.

The tank was located about 125 feet southeasterly from the main building at such depth in the ground that the sewers from the buildings would enter the arch near the crown, which would necessitate a covering of earth over the tank of four or
2689 five feet. That tank was provided with man holes, one over each section, which man holes were provided with the ordinary cast iron manhole curb and lid. These lids are tight as against circulation of the air, but will admit the drawing in of air in the second section of the tank as the sewage is removed by pumping. The pump pipe was a

separate pipe run down through the arch of the second section to a point near the bottom and was connected to a hand pump by which the sewage was lifted and discharged into the tank in the field to which the hose was connected for distribution.

This apparatus was used for about one year, and owing to the trouble which they had in the 2691
Winter in the discharge of the sewage or liquefied effluent upon the land by freezing, they obtained permission to turn their sewage into the Des Plains River in the subsequent year, which would be 1886. The plant operated during the good weather all right. The interference came with frost, which interfered with the distribution of the sewage on the 2692
ground. It froze and accumulated and made them trouble. When permission was obtained to drain into the Des Plains directly with the raw sewage the use of the tank and filtration area was abandoned and the sewers of the house and other buildings were turned directly to the Des Plaines River. I do not know or have forgotten how many people 2693
there were at Altenheim at that time, but the plant was designed to take care of one hundred or a hundred and fifty people.

Q. 8. Please proceed now to a full description of the plant constructed at the St. Joseph Orphan Asylum, stating when it was constructed and put into use, how long it was used, how it was operated 2694
and all about it, referring to any description or drawings relating thereto now present. A. I was called again in 1889 to consider a case at St. Joseph Orphan Asylum at West 40th Avenue near Belmont Avenue, in this city, in which similar conditions of level ground, inconvenient discharge, or

2695 a discharge of raw sewage at a very great distance and sewers deep below the surface of the ground made it necessary or desirable to put in a plant like that installed at the Altenheim, where the sewage was to be received, dissolved and lifted by a pump and distributed over a filtration area the ef-
2696 fluent from which was to be discharged into an open ditch. The quantity of sewage to be cared for each day was smaller than in the case of the Altenheim, being estimated at a possible maximum of 5,000 gallons in 24 hours, and the tank was consequently smaller than that of the Altenheim, being, as before, a horizontal cylinder of brick masonry,
2697 but five feet inside diameter, and 24 feet long. This was provided with a dam and a baffle near the middle of the tank affording a wide opening for outflow, an inlet for sewage in the arch of the section behind the dam, and a pump section running down nearly to the bottom in the section before the dam. As this plant was provided with steam for regular
2698 use a small duplex Worthington pump was used instead of a hand pump. The filtration area was prepared with under drain, but hydrants were used for distribution of the liquefied effluent which were connected to the distributing tank which received the sewage as it was pumped from the dissolving tank. On this occasion, thinking it of interest to
2699 the profession, to know how readily sewage could be handled with an ordinary pump, and upon filtration area or beds, by previously dissolving the sewage, I published in the Engineering and Building Record and the Sanitary Engineer, a journal published in New York and London, an illustrated description of the plant installed at the St. Joseph

Orphan Asylum. This was published in the issue of the journal of November 30, 1889, in the New York edition, and December 14, 1889, London edition. The illustration and description are found on page 386 of that issue, and the illustrations consist of a general plan marked "The St. Joseph Orphan Asylum Sewage Disposal," and of a plan of 2701
the dissolving tank, showing the same in sectional plan, vertical section, and two transverse sections, and also showing the distributing tank or wooden cistern from which the distribution pipe lead to the hydrants in the filtration area. These plans and sections of the tank being marked, "The St. Joseph Orphan Asylum Sewage Disposal Details," and 2702
with the following printed description of the plant:

"ST. JOSEPH ASYLUM SEWAGE IRRIGATION PLANT.

The St. Josephs Orphan Asylum is a four-story building recently erected on the prairie, near Chicago, Ill., two miles from the river or the nearest sewer. The building is intended for 2703
about 250 children, and is fitted with water closets, baths, laundry, etc. As no sewers were likely to be constructed in this district for several years, it was decided to aispose of the sewage by surface irrigation by a system here illustrated.

"Figure 1 is a diagram showing the arrangement of plant and the irrigation field. A is the asylum building, and B the pump room. Roof 2704
water is stored in the cisterns D D (connected by equalizing pipe F), and thence pumped into a roof tank for house supply; after it is used it is all (about 5,000 gallons per diem), collected in the receiving tank G, screened, pumped by a 6 x 4 6″ steam pump, brass fitted, through suction pipe S and force main K to the distributing Tank T; thence it is drawn off through hyd-

rants at H H, etc., and flowed over any portion of the irrigation area L L, which is 300 feet square and capable of extension westward, and drained off through the tile pipes II, etc., to pipe JJ that discharges into an open drain to the river, about 15 feet below the level of the ground at this point.

2706 The area L L L L is divided by low banks into 16 fields indicated by the dotted lines, which may be used alternately for intermittent irrigation. The pipes II, etc., are buried about 3 feet deep and rest on hard clay. The overlying soil is a porous clay up to within a few inches of the top, where it is a black loam. The pipe JJ is about 4.2 feet below the surface of the ground. The force main only is in danger by frost, and this
2707 is drained each time after using. C is a catch basin.

Figures 2 to 5 inclusive show the details of receiving tank G, Fig. 1; Fig. 2 is a section at W. W., Fig. 3; Fig. 3 is a section at X X, Figs 2 and 4; Fig. 4 is a section at Z Z, Figs 2 and 3, and Fig. 5 is a section at Y Y, Figs. 2 and 3. This tank is virtually a section of a brick sewer, with domed ends. A A are cast iron manhole covers, city pattern. B is the inlet, D is a dam, and T a
2708 trap wall, that also serves as a screen. The sill and apron pieces of dam D are each secured by 6 half-inch bolts O and C. Bolts O do not actuall appear in Fig. 3, but are shown there as if in plan.

Figures 6, 7 and 8 show the details of distributing tank T, Fig. 1; Fig. 7 is a plan with a part of the tank and floor boards removed, and Fig.
2709 8 is an elevation from D D, Fig. 6. There are 2 x 3 x 2″ mortised and tendon joints at A, and one and a half by one inch at F and F. B is a bearing lock spiked on. C is a 2 by ¼ inch iron stirrup secured by 4 one-half-inch leg screws. D is a dressed stone 18″ x 18″ x 6″. E is a quarried stone 24 inches square.

This work was designed and its construction superintended by William S. McHarg, C. E., Chicago, Ill., from whom we received dates and tracings, from which are prepared this description and the drawings for the accompanying illustrations.

The sewers, drains and tanks were built by Contractor William E. Dee, of Chicago, and the pump setting and iron pipe connections were the work of Browne & Kavanagh, of same city." 2711

The dimensions which I stated for the receiving tank should be corrected. I stated the dimensions to be 5 feet diameter by 24 feet long. The true dimensions are 6 feet diameter and 27 feet long internal dimensions. As a matter of recollection I made this error, as I stated the figure which I recollected to be shown in this di- 2712
agram, stating it from memory merely. By reference to this diagram I find it to be 6 feet by 27 feet. All dimensions and sizes shown on this diagram are correct, as this drawing was made at the time from the original for the purpose of publication.

In further answer to the question I will state 2713
that this system at St. Joseph Orphan Asylum was used in connection with the intermittent filtration of the liquefied effluent for a year or two, when the filtration was abandoned and the liquefied effluent was pumped up to the location of the distributing tank and allowed to flow away.
In 1895 a city sewer was built in Belmont Ave- 2714
nue, and the house sewers were connected thereto as a more convenient and a less onerous disposal. The tank and the distributing tank and filtration area were, of course, no longer used.

Counsel for defendants offers in evidence the publication in The Engineer-

2715 ing & Building Record and The Sanitary Engineer of November 30, 1889, and December 14, 1889, quoted by the witness in his foregoing answer and as quoted; and it is stipulated that a photolithographic copy of the page contain-
2716 ing such publication may be used in place of the original thereof, such photolithographic copy to be marked "Defendants' Exhibit St. Joseph Plant."

Q. 9. How did that plant at the St. Joseph Orphan Asylum operate, particularly with reference to solids in the sewage? A. The raw
2717 sewage was received into the receiving end of the tank with a continuing flow more or less as the sewage was produced in the building, and the solids were held by the dam and the trap wall or baffle until all organic solids were dissolved or liquefied and the liquefied effluent flowed over the dam in amount and rate equal to the inflow-
2718 ing sewage and collected in the section of the tank in front of the dam from whence it was pumped as desired, at least daily, to the distributing tank, from which it was discharged on the filtration area through the hydrant located at desired areas. The operation involved the two
2719 stages of purification, first the liquefaction of the organic matter in the tank, and subsequently the application to an aerated filtration bed where the sewage was exposed to light and air, and with special advantage in aeration in its discharge from the hydrant.

Q. 10. How did you come to construct the

plants referred to in your previous answers, particularly the ones at Altenheim and St. Joseph Orphan Asylum—that is, what were you aiming to accomplish and what led you to adopt this way of accomplishing it? A. The design and construction of this system was the natural sequence of other work in the disposal of sewage 2721
with which I was familiar previous to the time when I designed the Altenheim plant to the work of others and to my own work; and the use of a system so designed was natural because of the situation of the buildings and land where the disposal plant was to be installed. I had previous knowledge of the system accredited to Col. Waring in the disposal of sewage from isolated dwell- 2722
ings, that is, dwellings standing by thesmeslves and in a country where there were no public sewers in which to discharge the sewage and where it was impracticable to discharge in the ordinary method by which the sewage might be taken away inoffensively by water carriage. This 2723
system was that known as sub-surface irrigation, and involved the use of a tank divided into two sections or of two tanks, the first section of the single tank, or the first tank where two were used, receiving the raw sewage and holding a sufficient quantity so that the flow through the 2724
tank was gentle, and the second division of the single tank, or the second tank in which was set an automatic siphon which, when the overflow from the receiving tank rose to a certain point, compelled the starting of the automatic siphon and the discharge of the collected lique-

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fied effluent into a series of small tile laid with
open joints immediately below the surface of the
ground, preferably no deeper than nine inches
or ten inches where the liquefied effluent was
subjected under conditions of light and air favor-
able to the development of the bacteria necessary
2726 for the final stage of purification of the sewage.
I knew of the application of this system about
the year 1882. I was at this time employed by
the Durham House drainage Company as a super-
intendent in installing iron drainage and waste
systems in buildings, and we had the contract to
instal such drainage and waste in Blair Lodge,
2727 the residence of Walter C. Larned of Lake For-
rest. I was employed by this company from the
time I left the employment of the city of Chicago,
in 1879, until about the beginning of 1885. The
time when Blair Lodge was built was some lit-
tle time after I went with the company and my
work there was therefore set by me at about the
2728 year 1882. For the disposal of the sewage for
the house Mr. Benezette Williams, a civil engi-
neer of this city, designed and applied this sys-
tem of sub-surface irrigation in which and in
the action of which I was of course much in-
terested. I discussed the action with him and
2729 learned that the plant operated with practically
no permanent collection of solid matter in the
receiving tank, but that it was broken up and
carried along in a liquefied condition through
the action of bacteria. I subsequently designed
and applied that plant in the '80s and early '90s,
but I am unable to state the years I installed the

plants for George and Robert Scott at Lakeside, Illinois, this being a joint plant for two houses. I installed a plant at Lake Forest for what is now known as the Deerpath Inn—it was then known as the Johnson place. I designed a plant, furnishing plans and specifications, for a gentle-
man in Sioux City, Iowa. I installed a plant for 2731
one of the Norton Brothers at Geneva Lake, Wisconsin. There were others designed during these years. The latest plant up to 1895 was designed for Cyrus McCormick, and installed when his house was built at Lake Forest, which I think was in the year 1895. From my knowl-
edge of the process that went on in the receiv- 2732
ing tank, or receiving section of the tank, I was well informed as to what might be expected with the quantity of sewage usually cared for in these tanks, and what would occur if applied on a larger scale. The situation at the Altenheim, and at the St. Joseph Orphan Asylum required
that the sewage discharge into a tank fixed deep 2733
into the ground. In the ordinary use of sub-surface irrigation a place must be selected where the flow of sewage from the house to the tank and the discharge of the siphon through the buried tile may occur by gravity, that is, the land
where the tile are placed must be some feet lower 2734
than the basement level of the building to be drained. As I stated previously, the ground at the Altenheim and at the St. Joseph Orphan Asylum was level and the tanks were necessarily placed deep and covered. It was not convenient to make the second stage of purification by means

of the buried tile and the system of intermittent
filtration which was then displacing irrigation
as a more complete and more uniform kind of
treatment of sewage presented itself as a ready
means of obtaining the same result of aeration
and exposure in soil which was aerated and sub-
2736 ject to the direct action of light. This necessi-
tated raising the sewage from the deep tank by
pumping. I had seen at Pullman when the sew-
erage system was installed there in the early '80s
the difficulty with valves arising from the pump-
ing of raw sewage. Special valves were re-
quired which gave more or less trouble to keep
2737 in repair, and in smooth operation. There was
nothing at the Altenheim or subsequently at St.
Joseph to warrant an attempt to use special ma-
chinery. At the Altenheim it was necessary to
use a hand pump with an ordinary foot valve or
disc valves and at St. Joseph Orphan Asylum
the Worthington pump was fitted with ordinary
2738 disc valves. The natural deduction, therefore,
for me was that I should liquefy the sewage on
an adequate scale in the same manner that I had
previously liquefied sewage in the case of isolated
houses. I therefore designed the tanks which
have been described for the Altenheim and for
2739 St. Joseph Orphan Asylum. In doing so I used
means for retaining the sewage in one section
of the tank such as I had used before for isolated
houses, and have always used, differing from
Col. Waring's system which required the build-
ing of two tanks by building a single tank with
a dam and baffle, dividing it into two sections,

one to retain the necessary pool of sewage, the other to receive and collect the overflow until such time as it could be removed by the automatic siphon for the second stage of purification in the tile. As the apparatus proposed for the Altenheim and for St. Joseph Orphan Asylum differs only in size from that previously used it 2741
was certain that, all conditions being similar, the result previously obtained would be repeated in a larger plant. This was found to be true; the organic matter was liquefied with practically no insoluble residue or accumulation of sludge in the receiving tank, and the liquefied effluent was in proper condition to pass through the pumps 2742
without in any way wearing or clogging the valves beyond the ordinary wear through pumping clear water. The effluent was also in proper condition for further treatment. In proportioning the tanks to obtain this result I deduced from my previous experience with the Waring tank used in sub-surface irrigation, that there must 2743
be a volume of sewage retained in the pool practically proportionate to that retained in the Waring system. The receiving section, therefore, is designed to receive and hold several hours' flow and the collecting section of the tank is also made large enough to hold about half a day's flow. 2744
This last quantity is fixed generally by the fact that it was considered desirable in intermittent filtration to apply sewage to a particular bed but once during the day. The beds are arranged so that if necessary two beds may be used in the same day, or if necessary a third, coming around after 24 hours to the same bed for a second dose.

Complainant's counsel objects to such parts of the foregoing answer as give statements made by others, as being hearsay and not competent evidence.

Q. 11. Please state whether you have examined
2746 the Cameron, Commin and Martin patent, No. 634,-423, sued on in this cause and whether you understand the same? A. I have and do.

Q. 12. Please compare the construction and operation of the plants at the Altenheim and St. Joseph Orphan Asylum described in your foregoing answers with the construction and operation of the plant described in this patent, No. 634,423, and
2747 state wherein they are similar to or different from each other—limiting your comparison to Claims 1 to 8 inclusive, 11 and 12, and 20 to 22 inclusive of the patent. A. In both the instances, that is, at the Altenheim and St. Joseph Orphan Asylum of the use of dissolving tanks, or as they would now be called, septic tanks, on a larger scale than before,
2748 the operation of the tanks was perfect, the steps are those described, in the patent in suit, and the result is that therein described, and the qualities of the resultant, the liquefied effluent, are equal.

In both these instances and in the patent in suit, the final stage in the process of purification is the same, "subjecting the liquid effluent to air and
2749 light," and the result of the process used in these instances and described in the patent in suit when intelligently applied is a highly purified final effluent.

If the process and the apparatus set forth in the patent in suit be compared claim by claim with the process and apparatus used at the Altenheim

and St. Joseph Orphan Asylum it will be found that the process is identical, and that the variations and the apparatus are due only to a different selection of devices well and commonly known and used in the art to accomplish certain results, or to mistaken ideas of cause and effect in the operation
described, or to wrong values given to words used 2751
in description.

The first claim of the patent in suit is for "the process of purifying sewage which consists in subjecting the sewage under exclusion of air, of light, and of agitation to the action of anaerobic bacteria until the whole mass of solid or organic matter
contained therein becomes liquefied, and then sub- 2752
jecting the liquid effluent to air and light."

In the tanks built in 1885 and 1889 at the Altenheim and at St. Joseph Orphan Asylum there can be no question that the process is the same as that referred to in Claim 1. The tanks are under ground, deeply covered, with no opening to the air,
except a small vent pipe to allow the escape of 2753
gases set free in the process. Air and light are therefore excluded. The inflow of sewage from the inlet set just above the constant water line of the tank is insufficient to cause injurious agitation, and the fact that liquefaction as claimed does take place, shows that injurious agitation does not take
place. 2754

It is with regard to the term "exclusion of agitation," and to the terms commonly used in the following claims "non-disturbing inflow and outflow" and "non-disturbing inlet and outlet," that the proper value and meaning must be given. Speaking exactly, it is not possible that there shall

be an addition to a pool or body of water or an inflow or outflow to a pool or body of water with "exclusion of agitation," or non-disturbance, and therefore the meaning of these terms in the claims must be taken to be without injurious agitation or injurious disturbance; and while speaking of a
2756 non-disturbing inflow and outflow using the term in the above sense, I wish to make it clear that the degree of agitation or disturbance is not due primarily or principally to the location of the inlet above, below or at the normal surface of the water in a pool or to the shape of the inlet or outlet, but to the proportion which exists between the volume
2757 of water contained in the pool and the volume of incoming water in a given time. It is evident that in a large pool of water a small trickling stream may fall from a height, or may be admitted at the surface of the pool, or at any point below, without material disturbance, and that conversely a large stream flowing rapidly into a small pool will pro-
2758 duce severe agitation or disturbance whether the inlet be placed at any one of these three locations.

In most of the processes used in the purification of sewage, whether it is desired to obtain septic action, subsidence, or precipitation, it is common to require that a pool of sewage be secluded and as most of the processes are continuous that an in-
2759 flow and outflow of sewage be permitted which shall not produce agitation or disturbance to such a degree as to prevent the active development and operation of bacteria, rapid subsidence where sedimentation alone is desired, or where chemical processes are used and rapid precipitation is desired. To attain this result, engineers or persons engaged in the treatment of sewage have used many devices,

and it is common to find tanks in combination with submerged inlets and outlets with inlets turned down and outlets the same, with baffles closing a large part of the whole of the width of the pool and extending downward a greater or less amount to find inlets broadened for a large part of the width of the tank, so that the flowing stream is re- 2761
duced to a thin sheet falling from a lip practically at the surface or above the surface of the water in the tank, the use of bell mouths on inlets and outlets.

The most common difficulty in the seclusion of a pool in which inflow and outflow are permitted is in the 2762
case where the inlets are on a level of the water surface in the tank that a surface flow sets up directly across the tank, so that the inflowing sewage passes rapidly through the tank, not disturbing the body of water in the tank, nor displacing it to cause a forward movement of the whole body of water which is desirable in most processes. This 2763
forward movement enabling a fresh body of sewage to come under the influence of the quiescence due to the pool. With submerged inlets and outlets or a combination of a submerged inlet and surface outlet restricted in size this same direct flow through may set up in a pool so that the inflowing sewage passes through without material disturb- 2764
ance of the body of water in the pool, and the object permitting the sewage to form a pool is lost, because there is no quiesence or restriction of flow to the flowing stream. This also has been met by the devices described above.

Adjourned till Thursday, August 10, at ten o'clock A. M.

2765 WILLIAM S. MACHARG.

August 10, 1905.

Met pursuant to adjournment; present as before.

The witness continues his answer.

The collection of these devices commonly used
2766 in connection with tanks for the purification of
sewage into combination with a tank now called a septic tank, appears to me not necessarily invention, and some of these devices have been used in connection with tanks which would now be called septic tanks, as in the case of the Altenheim and St. Joseph Orphan Asylum plants. In Claim 5, the statement is as follows: "In an apparatus for
2767 the purification of sewage, the combination of a
septic tank having an outlet disposed above the bottom and below the normal water level of the tank and open across the greater part of the width thereof, and an aerator connected with said outlet." In the tanks used at the Altenheim and at St. Joseph Orphan Asylum, and in all tanks used
2768 by me in the process of disposal known as sub-surface
irrigation, this construction has been used. As the tanks at Altenheim and St. Joseph Orphan Asylum were naturally deduced by me from the smaller system, the baffle and dam are identical with those used in the smaller system; and it is readily seen by reference to the drawings of the
2769 tank at St. Joseph Orphan Asylum that in passing
from the secluded pool into the second section of the tank the liquefied effluent must pass under the baffle T, and over the dam E, fully satisfying the claim of an outlet disposed above the bottom and below the normal water level of the tank and open across the greater part of the width thereof. It

further happens that the thin sheet of liquefied effluent flowing down the external surface of the dam is aerated. The aeration at this point is, however, of comparative unimportance, because in the handling of the liquefied effluent before it reaches the irrigation area, and really as a part and continuation of the process, is thoroughly aerated by 2771
pumping into the distributing tank, and especially by the open discharge from the hydrants onto the ground.

The drawing which I now produce of the sewage disposal system for the residence of Slason Thompson, Esq., at Lake Forest, Illinois, shows the tank or flushing basin used by me in the time testified to 2772
in connection with the sub-surface system of irrigation. The general design of an elongated tank with curved corners, as shown, has been used by me, but there have been slight variations in form from the semi-circular end. The receiving tank has usually contained from 75 to 100 gallons of sewage, or about two barrels, making the secluded 2773
pool which is referred to in this case. The sewage has flowed in as shown in the vertical section by a 6 inch sewer from house. The liquefied effluent has passed under the baffle or trap and over the dam, running down the outside face of the dam until the second chamber is filled to the point of discharge substantially as just described for the tank at St. 2774
Joseph Orphan Asylum.

In Claim 12, "in an apparatus for purifying sewage, the combination of a septic tank, an inlet occupying the greater part of the width of said tank," is a description of a device commonly used in connection with tanks for secluding a pool of sewage,

2775 namely, a wide opening from the inflowing channel made in the wall of the tank at or about the normal water surface level, so that the sewage spreads out into a thin sheet and flows into the tank gently, or practically with non-disturbance. I offer a print, showing details of precipitation tanks which
2776 are a part of the sewage disposal works built by me at the second hospital for the insane, now called the Rochester Hospital for the Insane, and in which this device is used to secure a gentle flow into the tank. As shown upon the print and indicated by the arrows, the water flows in through the influent channel from the screen chamber and
2777 flows the entire length of the tanks, turning at the end and flowing into the adjacent tank through a wide opening. At this opening and at similar openings out of this tank and into and out of the other remaining tanks, the grooves are shown by lines in which stop-planks may be placed. Similar grooves are shown on the line of the circulating channel
2778 through which the sewage flows from the first tank into the second and so on. In the transverse section is shown the arrangement of influent channel, circulating channel and effluent channel, and also a dotted line shows the normal water level in these tanks, and this water level is on a level with the bottom of the openings from the circulating chan-
2779 nel above mentioned, and on a level with the bottom of the openings into the effluent channel, which openings with their grooves for stop planks are shown in plan. There are also shown in plan and in section baffle boards, or partitions of plank extending a large part of the length in each of the first three tanks, which are intended to prevent

surface flow referred to in my evidence yesterday, which surface flow, in the absence of this baffle board would certainly set up between the inlet opening and outlet opening on this tank immediately along or adjacent to the wall between the tank and the circulating channel. This construction of tank and baffle boards makes this device as 2781
intended an inlet occupying a large part of the width of the tank, and its intent is to produce a gentle and non-disturbing inflow into the tank, and is practically the device claimed in combination with the septic tank in Claim 12.

In claim 6: "In an apparatus for purifying sewage, the combination of a drain or sewer, a 2782
settling tank connected therewith and adapted to receive the contents thereof, a septic tank connected with said settling tank." This insertion of a settling tank or chamber to catch and retain heavy material is common in tanks used with purifying processes and is simply adapted in this claim. In the print thus produced of the sewage 2783
disposal works at the Rochester Hospital for the Insane, Minnesota, a screen chamber, so-called, is shown, on the line of the sewer, and in combination therewith, and connected to the influent channel, and so to the tanks. This chamber, which is here called a screen chamber, is to catch articles which are heavy enough to settle to the 2784
bottom, and is provided with a screen which, in the case of insane hospitals, is essential, owing to the fact that in addition to heavier articles, articles of bedding or wearing apparel are frequently and commonly thrown into the water closets and other plumbing fixtures by the insane

2785 patients. The function of this chamber is, of course, to retain heavy articles or light and is identical with the use of the settling tank in connection with the septic tank in the claim insofar as relates to the retention of heavy material.

Still referring to the above plan, I wish to call
2786 attention to the design of these tanks, which intends the use of a baffle to compel the flow of the sewage in a particular manner without in any way disturbing the flow except by giving it direction. In these cases the flow of the water is horizontal around the end of the baffle. In the case of the tanks at Altenheim and St. Jo-
2787 seph Orphan Asylum and of the tanks used in connection sub-surface irrigation this flow is vertical, passing under the baffle and over the dam. This use of a baffle to produce a gentle flow in the desired direction is much older than anything which I have cited heretofore in this testimony. To my knowledge the baffle in front of
2788 the sewer outlet in tanks and basins has been used in connection with all private houses, hotels and most other buildings in the city of Chicago since 1871, and was then an old and common device. These tanks or basins are commonly called catch basins, or private catch basins,
2789 and are universally applied in Chicago to prevent the ingress of hot grease and soapy water which readily coagulates, or the coagulation produced in soapy water in the laundries to prevent these materials entering the public sewers where, as is well known, they adhere to the sides, forming obstruction, and more particularly from the

long connecting private drain under the house
where they are more likely to collect and form
stoppage, causing, so far as the public is con-
cerned, frequent digging up of the streets. This
condition is particularly true of Chicago, where
the gradients to the sewers are very slight, and
this method of keeping private and public sew- 2791
ers free of this stoppage was early resorted to.
This baffle, commonly called a trap, is built above
the bottom of the basin and below the normal
water surface in the basin, and is extended up
above the water and connected to the catch basin
wall, the whole structure, baffle and basin, being
commonly of brick masonry. The object of this 2792
baffle, which extends entirely across the basin, is
to produce a gentle flow which will not disturb
the retained grease and other matter which forms
a heavy scum on the surface of the water, and I
wish to say that it is probably from knowledge
of this device and its efficacy that I deduced the
design of tank used in the system of sub-surface 2793
irrigation, and afterwards carried into the Al-
tenheim and St. Joseph Orphan Asylum plants.
The common dimensions for a single house es-
tablished by authority are that the basin shall
be of brick circular in form, three feet inside di-
ameter, and two and one-half feet deep below 2794
the outlet. The distance to which the baffle must
be carried below the water surface I do not re-
call, but it is commonly about one foot. For ho-
tels, restaurants and at other places, as in con-
nection with the operating houses at the Stock
Yards, these basins are made much larger. I cite

2795

this simply as an instance of a method described
in the claims of an outlet below the normal water
surface and above the bottom and extending
nearly the full width of the tank, specifically set
forth in claim 5, claim 6, claim 11 and claim 22.

As regards claim 2 of the patent in suit, the
2796 tanks built and operated at the Altenheim and
St. Joseph Orphan Asylum, and the smaller
tanks used with sub-surface irrigation do liquefy
the solid matter contained in sewage by a pro-
cess which consists in secluding a pool of sew-
age having a gentle inflow and outflow from light,
air and injurious agitation until a mass of mi-
2797 cro-organisms has been developed of a character
and quantity sufficient to liquefy the solid mat-
ter of the flowing sewage, the inflow serving to
sustain the micro-organisms, and the said pool
is then subjected, but as it is the same pool the
process is continuous, or rather coincident with
the portion of the stage of purification already
2798 described; and the said pool is then subjected
under exclusion of light and air and under a gen-
tle inflow and outflow to the liquefying action of
the so cultivated micro-organisms until the solid
organic matter contained in the flowing sewage
is dissolved. All the requisite conditions de-
2799 scribed in the claim exist in the tanks at the
Altenheim and at St. Joseph Orphan Asylum, and
in the smaller tanks used in the system of dis-
posal by sub-surface irrigation, and the result is
that the solid organic matter is liquefied and that
which flows away from said tanks is a liquefied
effluent.

As regards claim 3, which is a repetition of claim 2, with the addition of the following: "and then subjecting the liquid outflow to an aerating operation," the process used at the Altenheim and at St. Joseph Orphan Asylum in addition to fulfilling the repeated part of claim 2, satisfy the added portion of the claim in the 2801
treatment of the liquid effluent to an aerating process in distributing it upon the filtering area in the case of the Altenheim and St. Joseph Orphan Asylum plants, and in the case of the smaller tanks by its discharge into the surface soil through the tile laid with open joints as described. 2802

As regards claim 4, which is a repetition of claim 3, with the following addition: "and then to a filtering operation." The plants at the Altenheim and St. Joseph Orphan Asylum, as above stated, fulfil the conditions of claim 3, and in the description of the plants before made the filtering areas and preparations of same are fully de- 2803
scribed. In the smaller tanks used in connection with sub-surface irrigation the same process of filtration follows the discharge into the upper surface soil, but it is not always necessary to underdrain the area, as is the case with larger quantities of sewage.

As regards claim 5, the tanks at the Altenheim 2804
and at St. Joseph Orphan Asylum possess the outlet described, but the aerating process is subsequent to the liquefied effluent leaving the tank. The same statement will apply to the smaller tanks used in connection with sub-surface irrigation.

2805

In claim 6 the introduction of a settling tank, in combination with a drain or sewer, I have shown was used by me at the Rochester Hospital for the Insane, and I do not consider that any invention is used in applying same to a septic tank.

2806

As regards claim 7, the use of an outlet comprising a conduit having a longitudinal slot open across the greater part of the width of the tank, no conduit or pipe is used slotted or otherwise in such manner in any of the tanks that I have built. The same statement applies to the slotted pipe outlet described in claim 8.

2807

In claim 11 the outlet extending across the greater part of the width of the tank and disposed above the bottom of the tank and below the normal water level thereof was used by me to discharge the liquefied effluent from the secluded pool at the Altenheim and St. Joseph Or-
2808 phan Asylum plants, and in the case of all smaller tanks used in sewage disposal by sub-surface irrigation.

In claim 20 I have used the apparatus as described in the plants at the Altenheim and St. Joseph Orphan Asylum, and smaller tanks above mentioned, but have not used the specially
2809 claimed broadened mouth inlet and outlet.

As regards claim 21, the process has been used by me as described in claim 2, and herein again described, but I have no knowledge as to the formation of a thick scum in connection therewith.

As regards claim 22, the plants at Altenheim, St. Joseph Orphan Asylum and the smaller tanks in connection with sub-surface irrigation, use the apparatus as described, except that the inlet is not disposed below the water surface.

Counsel for defendants offers in evidence the following drawings referred to by the witness in his foregoing answer, viz.: 2811

1. Blue print entitled "Sewage Disposal System for Residence of Slason Thompson, Esq., Lake Forest, Ill.;" and the same is marked "Defendants' Exhibit Thompson System."

2. Two sheets of lithograph drawings, 2812
entitled Sewage Disposal Works. Second Minnesota Hospital for the Insane;" and the same are marked "Defendants' Exhibit Rochester Plant."

Complainant's counsel objects to all those parts of the last answer that relate to the Rochester plant, to the plant 2813
or system at Blair Lodge, Lake Forest, and to other plants of which no drawings showing the construction of the plants as actually installed have been offered; and objects also to the introduction of the above-mentioned 2814
exhibits, as secondary and not the best evidence.

Q. 13. Please state whether the sewage disposal plants at the Altenheim and St. Joseph Orphan Asylum described in your foregoing answers were used publicly and in the ordinary

2815

way and for the ordinary purposes for which they were constructed.

Last objection repeated.

A. They were so used. The plants were built
publicly and were open to inspection, were un-
derstood by the people, boards and otherwise for
2816 whom they were being built, and were used open-
ly and were accessible to persons desiring infor-
mation in regard to same.

Q. 14. You have just stated off the record
that you have omitted one or two points which
ought to have been brought into your answer to
2817 question 12. I now ask you to make such ex-
planation of these points, or reference to them, as
you may consider necessary to a full and truth-
ful statement of the matters in question. A. In
describing different devices commonly used in
and about tanks provided for septic action, sub-
sidence or precipitation I neglected to refer to
2818 one more directly used in the patent in suit,
namely, an outlet situated below the normal
water surface and above the bottom, this device
being used as particularly well adapted to re-
move gently the liquefied effluent without dis-
turbing the scum or floating material lying at or
near the normal water surface, or the heavier
2819 material lying on the bottom of the tank. This
device was used by Colonel Waring in the re-
ceiving tank of his sub-surface irrigation sys-
tem for the purpose of removing gently the lique-
fied effluent from this first tank into the tank in
which was set the automatic flushing siphon
which discharged the accumulated liquefied ef-

fluent into the series of tiles laid with open joints immediately below the surface of the ground in the irrigation area. This outlet located below the normal water level and above the bottom of the tank is shown in a cut printed on page 184 of a book entitled "The Disposal of Household Wastes," by William Paul Gerhard, 2821
C. E., and published by D. Van Nostrand Company, New York, 1890. This device and its use are described by Mr. Gerhard on page 74 of the same book as follows:

"An important and most necessary precaution to prevent the clogging of the siphon or the equally annoying frequent stoppage of dis- 2822
tribution tiles is to build in connection with the flush tank, and between the house and the latter, an intercepting chamber or grease trap, intended to intercept all solids, undissolved paper, and fatty waste matters of the kitchen. Such a chamber is, in a certain sense, a cesspool, although differing from the ordinary objectionable device of this kind, in having its liquid contents frequently changed, and in being built of small 2823
size. The emptying and cleaning of this chamber must, of course, not be neglected. Much of the solid matter and paper, etc., is reduced by maceration and decomposition, and flows dissolved by water into the liquid sewage chamber. The overflow pipe connecting both must dip well below the surface of the water level in the first chamber, in order to prevent scum or grease from overflowing into the flush tank." 2824

I wish to say further in this connection that in constructing sewerage systems for buildings between the years 1879 and 1885, I frequently used this device in the catch basin which receives the kitchen and laundry wastes of dwellings, hotels and other buildings, which catch basins I described

2825 in answer to question 12 as a substitute for the baffle or trap to accomplish the removal gently of the liquid in the catch basin without disturbance of the floating scum or grease and without the disturbance of the heavier matter which settles at the bottom; and I have further, since that time,
2826 specified this method of discharging the liquid contents of catch basins in preparing plans and specifications for such work.

In so far as this outlet located below the normal water surface of the tank and above the bottom of the tank appears in the claims in the patent in suit, I wish it to be understood that I consider there is
2827 no invention in its combination with the septic tank.

Counsel for defendants offers in evidence the quotation from the book entitled "The Disposal of Household Wastes," made by the witness in his foregoing answer, and as made; and it is stipulated
2828 that either party may produce said book and use the same for any and all proper purposes at the hearing of this cause.

Cross-examination by Mr. Fisher:

XQ. 15. Please state the various kinds of sewage disposal systems designed or installed by you between the year 1879 and the year 1896? A. I
2829 installed systems for sewage disposal by sub-surface irrigation with no substantial difference in the design or construction or mode of operation. I also installed sewage disposal systems by intermittent filtration without any tank system, one at the Soldiers' Home, Quincy, Illinois, in or about 1892, one at the National Soldiers' Home, at Milwaukee,

 2830

Wisconsin, in or about the year 1894. I also installed a system by intermittent filtration in which tanks were introduced as an alternative system at the Second Hospital for the insane, now called the Rochester Insane Hospital, at Rochester, Minnesota, in or about 1892. I also installed and oper-
ated a system of sewage purification by chemical 2831
precipitation at the World's Columbian Exposition in or about the years 1892 and '3. I also installed a system by intermittent filtration in which a closed tank was used for liquefying the solid organic matter at the Altenheim, Chicago, in the year 1885. I installed a similar disposal by intermittent filtra-
tion in which a closed tank was used to liquefy the 2832
solid organic matter at St. Joseph Orphan Asylum, Chicago, in the year 1889.

XQ. 16. If I understand your last answer correctly, it is that the various sewage disposal systems designed or installed by you for sub-surface irrigation comprised tanks, the construction and
operation of which were without substantial differ- 2833
ence. Is that correct? A. Yes, sir. These are without substantial difference except slight changes in the receiving chamber. In many the receiving chamber is slightly smaller than in the one offered this morning in evidence, marked "The Slason Thompson System." The receiving tank or-
dinarily contains about two barrels of sewage, 2834
while a slight variation in shape makes this a little larger.

XQ. 17. How many of these sewage disposal systems having tanks and intended for sub-surface irrigation have you installed? A. I have installed probably more than ten, and less than thirty.

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XQ. 18. Was the last one at Mr. Slason Thompson's at Lake Forest? A. Yes, sir.

XQ. 19. And when next before that did you instal such a system? A. I think the previous one was two years ago, possibly three, for Mr. E. H. Barton, of the Western Electric Company, at Hins-
2836 dale.

XQ. 20. Were the relative sizes of the receiving tanks and of the flushing tanks or compartments in the various sub-surface irrigation systems installed by you about the same as the Slason Thompson system? A. In the Slason Thompson system, the receiving
2837 section is somewhat larger in proportion than the siphon end, owing to the fact that it was to be built of concrete and the semi-circular ends made in a more convenient form to build.

XQ. 21. In the Slason Thompson system, the receiving section of the tank is intended to hold about two hundred gallons, is it not? A. Yes.

2838 XQ. 22. Did all the tanks designed by you for sub-surface irrigation system have baffle walls? A. Yes, sir.

XQ. 23. Did you ever design or instal any intermittent filtration sewage disposal systems other than those mentioned in your answer to XQ. 15? A. Not to the best of my recollection.

2839 XQ. 24. So that if I understand you correctly, you have installed altogether from ten to thirty sub-surface irrigation systems; two intermittent filtration systems without any tank intermittent filtration system having open tanks, a chemical precipitation system, and the two systems that you installed respectively at the Altenheim and St.

Joseph Orphan Asylum, Chicago? A. Yes, sir, that is correct as nearly as I recollect.

XQ. 25. Did you ever design any sewage disposal system for any village, or for any institution other than the institutions hereinbefore mentioned by you? A. I do not recall any at the present moment. 2841

XQ. 26. Please describe in a genral way the construction of the sewage disposal plants for the World's Columbian Exposition in 1892-3? A. The executive committee realized that it would not be desirable to have visitors at the World's Fair looking at the discharge of raw sewage in front of the grand promenade, and at a distance of a mile and 2842
a half, a water works in-take crib, supplying drinking water for the Fair. They asked that at least a clarifying process should be used. After considering the condition existing at the World's Fair grounds and different methods of sewage disposal, I considered that an adaptation of tanks installed at Dortmund, Germany, using chemical treatment, 2843
would give a sufficiently good effluent so that it might be discharged into the lake near the shore. This system consisted of a series of iron tanks, each cylindrical in its upper section with a deep conical bottom installed wholly above the ground level, to which the sewage was delivered by the system of receiving and pumping apparatus known 2844
as the Shone System. Each of the Dortmund tanks was fitted with a descending pipe in the center of the tank extending down the full depth of the cylindrical portion of the tank, and terminating with radical arms triangular in section and open on the bottom. Each tank was also fitted with

shallow collecting troughs near the top of the cylindrical portion which united in one outlet passing through the side of the tank, the outlets from all tanks delivering into one effluent pipe which connected with the sewer built in the ground and discharging into the lake. Adjacent to each tank was
2846 installed a box with a trough leading to a point adjacent to the descending pipe in the middle of the tank before described. This box was used for the supply of chemicals. Centrally located and above the top of the four tanks was a receiving tank set so that pipes leading from the bottom of this receiving tank connected to the descending pipe in
2847 the center of each Dortmund tank. The rising main from the Shone ejectors discharged on a screen located above the receiving tank, the water flowing into the receiving tank and through the connecting pipe to the descending pipe in the Dortmund tank in use at any time. The chemical tank before described was operated by placing the chemi-
2848 cals in the said tank and admitting a small run of water which carried the chemicals through the trough above described, which was connected into the top of the descending pipe, so that the sewage flowing from the receiving tank mingled with the chemicals, was carried down to the bottom of the descending pipe and flowed out under the triangular
2849 arms, which triangular arms gradually diminished in size so that the inflowing sewage was uniformly distributed at the bottom of the cylindrical portion of the Dortmund tank. The chemicals immediately performed their function and the sludge was precipitated from the rising water which was clear as it rose to the top and overflowed into the collecting

 2850

troughs before described, through which this clarified effluent flowed away through the before described sewers to the lake. The sludge slowly settling into the conical bottom was removed as necessary by a pipe which was connected to a tank set in a convenient place in the tank house, and which
was operated by a pump or by exhaustion of air 2851
to draw out the sludge into this tank which was a closed tank and from this tank the sludge was forced by compressed air into a filter press, the liquid extracted and the resulting sludge cakes were burned in the crematory provided for the destruction of garbage and sewage sludge. Each of
the Dortmund tanks held about 225,000 gallons 2852
of sewage.

XQ. 27. Can you state approximately the cost of the sewage disposal system of the World's Columbian Exposition? A. I can state what I think was the cost of the plant and buildings, and yet it is not certain that this is right, I think it was about $125,-
000. 2853

XQ. 28. Were all the sub-surface irrigation tanks designed by you substantially the same in construction and operation as the sub-surface irrigation tanks of Colonel Waring's system? A. They varied in this respect: First, that as a measure of economical construction I have always
built a single tank with dividing dam and baffle, 2854
instead of building the two tanks which I have ordinarily seen in public statements were used by Colonel Waring. Secondly, instead of a submerged pipe overflow between the receiving chamber and the siphon chamber, I have always used the baffle and dam. The operation would be substantially the same.

XQ. 29. Do you understand the tanks of Colonel Waring's system to be those illustrated upon page 184 of the books entitled, "The Disposal of Household Wastes by William Paul Gerhard," referred to by you in a previous answer? A. I understand that to be substantially the arrangement used by
2856 Colonel Waring which involved the use of two tanks, one as a receiving chamber and the other as a siphon chamber, but this particular design may be as used by Mr. Gerhard.

XQ. 30. Do you consider that there is any substantial or material difference in construction and operation between the sub-surface irrigation
2857 tank which you say you have installed and the tank which you installed at St. Joseph Orphan Asylum, Chicago? A. As to construction, the form is changed for convenience, but in general there is no difference in the construction except that due to the larger amount of work to be done. As regards the operation, the process is
2858 probably exactly the same and was intended to be the same. Of course the method of removal of the liquefied effluent is different.

XQ. 31. What was the cost of the sewage disposal system installed by you for the Second Hospital for the Insane at Rochester, Minnesota, in
2859 or about 1892? A. Approximately $7,000.

XQ. 32. About how many persons were supposed to be served by this Rochester Insane Hospital system? A. To the best of my recollection, twelve hundred.

XQ. 33. What sewage disposal system other than a sub-surface irrigation system for a resi-

 2860

dence did you instal next after the St. Joseph
Orphan Asylum system? A. The disposal sys-
tem for the World's Columbian Exposition and
the disposal system for the Soldiers' Home, at
Quincy, Illinois. The first was begun in 1892,
and the second was begun and completed in 1892.
Next came the Rochester system in 1892, already 2861
described, and the disposal system for the Na-
tional Soldiers' Home at Milwaukee, Wisconsin.
With the exception of small sub-surface irriga-
tion plants I installed no other plants for sew-
age disposal, so far as I recollect, until the in-
stallation of the plant designed in compliance
with my specification for the disposal of sewage 2862
at the shops of the Allis-Chalmers Company,
West Allis, Wisconsin, in the year 1903.

XQ. 36. The Allis-Chalmers Company has
been sued for the use of the sewage disposal
plant which you installed for them, has it not?
A. I am so informed. 2863

Adjourned till Friday, August 11, 1905, at 10
o'clock A. M.

August 11, 1905, met pursuant to adjournment;
present at before.

XQ. 37. Please state, if you can, the cost of
the sewage disposal plant at the Soldiers' Home 2864
at Quincy; and also the cost of the sewage dis-
posal plant at the National Soldiers' Home
at Milwaukee, and the number of
persons intended to be served by these plants, re-
spectively. A. I have no recollection of the
cost of the work at these two places. I have no

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recollection of the number of persons at the Soldiers' Home at Quincy, and I think there were about 2500 served by the plant at the National Home, Milwaukee, Wisconsin.

XQ. 38. Can you not approximate the cost of the two plants inquired about, or furnish a
2866 statement as to the cost of such plants from your memoranda? A. Owing to lapse of time and other circumstances I have no memoranda relating to these plants. At the Soldiers' Home at Quincy, Illinois, the existing system of sewerage was sot interfered with further than to connect to the existing sewer a short distance back
2867 from its outlet into a neighboring brook. The work done was a preparation of a filtration area of about three-quarters of an acre by underdraining the same, delivering into the adjacent brook, and by dividing the surface with earth banks into convenient beds which were laid out under the ridge and furrow system. An open
2868 channel of half tile fitted with stop gates was provided to flow the sewage over the desired bed. The whole work probably cost no more than two thousand dollars.

At the National Soldiers' Home, in Milwaukee, the conditions were similar, the number of per-
2869 sons served was considerably larger than at Quincy, and the area of ground prepared was larger. The area of it I do not recall, but it probably cost less than five thousand dollars. In both these statements the work of which the cost is given is the added work, that is, the work involved in the change and the old work to

which this added work was connected is not included in the cost.

XQ. 40. In the course of your direct testimony you have quoted from a book entitled "The Disposal of Household Wastes by William Paul Gerhard, C. E." State how long you have known of Mr. Gerhard and whether he was regarded as 2871
an authority on the subject of sewage disposal. A. I think I have known of Mr. Gerhard since about the year 1890. I have known of his work only in relation to plumbing and drainage of buildings, which included sewage disposal from the building in some instances as outlined in the book referred to. I do not know him as an au- 2872
thority in the art of sewage disposal.

XQ. 41. Are you familiar with Mr. Gerhard's book, "The Disposal of Household Wastes," and if so, how long have you been familiar with that book? A. I am not specially familiar with that book. When I bought it I read it and I have only referred to it on this occasion for a descrip- 2873
tion of the overflow used by Colonel Waring between the receiving tank and the siphon chamber used by him in connection with the system of sewage disposal by sub-surface irrigation.

XQ. 42. At the time that you read Mr. Gerhard's book did you question the fact that he 2874
expressed fairly therein the generally entertained opinions of the better class of civil engineers with respect to the subjects treated of in the book? A. I do not remember what impression was made upon me by Mr. Gerhard's book at the time I read it.

XQ. 43. Referring now to the irrigation plant designed by you for St. Joseph Orphan Asylum, please state whether or not the drawing illustrating the receiving tank is upon a scale? A. It is.

XQ. 44. Did you ever see the St. Joseph Orphan Asylum tank or plant in operation? A. No,
2876 sir.

XQ. 45. So that of your own knowledge you cannot speak as to the various conditions under which the receiving tank and other parts of the system actually operated? A. Not of my own observation.

XQ. 46. How far was the inlet opening of the
2877 tank above the water line—I mean the normal water level of the tank? A. It was built as shown, and it is about six inches above the normal water level. It is about one-third the way between the end of the tank and the dam. It is, as shown, a six-inch pipe.

XQ. 47. Did this inlet pipe project into the
2878 tank any distance? A. Merely sufficiently to allow bricking in.

XQ. 48. Did you ever examine the effluent from the tank of the St. Joseph Orphan Asylum system? A. No, sir.

XQ. 49. State how the pump by which the ef-
2879 fluent was removed was connected to the tank of the St. Joseph Orphan Asylum system. A. The pump was a Worthington pump set in the pump room shown upon the plan connected by a suction pipe running over to and down into the tank at the effluent chamber nearly to the bottom of the tank.

XQ. 50. State the character of pipe that led into the effluent tank from the pump and how this pipe entered the effluent tank? A. The pipe was wrought iron pipe of the proper diameter for the pump opening, possibly three inches in diameter, which entered the tank either at the manhole over the effluent chamber or through 2881
the arch of said chamber, and was provided with a foot valve at the bottom.

XQ. 51. Have you ever written or published anything on the subject of sewage disposal other than the description of the St. Joseph Orphan Asylum sewage irrigation plant that has been introduced in evidence? A. As editor of the 2882
sanitary department of the Building Budget, an architectural journal, published in Chicago monthly during the years 1886 to 1890 perhaps. I have discussed these matters somewhat, and I do not recall any other writing or any other publication.

XQ. 52. Did you ever at any time prior to 2883
1897 write or publish a statement to the effect that the action of a sub-surface irrigation tank or of a tank like that installed by you at St. Joseph Orphan Asylum, was other than or different from the action of subsidence or precipitation? A. Before answering this question I de- 2884
sire to amend my answer to the previous question by saying that I have also written regarding these matters in the Inland Architect of this city, also a monthly journal. This may be at any time between the years 1885 and 1904.

In reply to this question I do not recall a pos-

itive statement as to what occurs in the receiv-
ing tank of the sub-surface irrigation, but in the
issue for December, 1888, of the Building Bud-
get, I made the following statement in discussing
the project of disposal of the sewage of the city
of Chicago by the process of dilution in the pro-
2886 posed drainage canal: "Bacteriology is a branch
of science of recent origin in which few facts
are yet clearly defined and established; these
facts, however, give promise that the science will
aid wonderfully in the control of preventable dis-
ease. . . . We know that the food of bac-
teria is dead organic matter; that they increase
2887 with wonderful rapidity under favorable con-
ditions; that their period of existence is un-
known."

XQ. 53. During the recess which occurred
after the last answer, have you made any effort
to ascertain whether or not you have published,
prior to 1897, any such statement as is called for
2888 by XQ. 52? A. I have done so, and found pub-
lished in The Inland Architect, of September,
1895, a description of an apparatus and plant for
the sub-surface disposal of the sewage of a coun-
try house with a discussion of the system of such
disposal. This article is published under my
2889 name.

XQ. 54. What was the capacity of the St. Jo-
seph Orphan Asylum tank below the water line?
A. The receiving chamber would hold between
1300 and 1400 gallons; and the overflow chamber
would hold about 2200 gallons.

XQ. 55. All the articles in the Building Budget published under the name of William S. MacHarg, were written and published by you, were they not? A. They were either written and published by me or acted on editorially by me.

XQ. 56. You were the editor of the Sanitary and Engineering Department of the Building Budget and as such editor you were at liberty to 2891
express such views as you wished upon subjects falling within your department, were you not? A. Yes, sir.

XQ. 57. When did you first see or hear the word "septic" used in designating a sewage disposal tank? A. It is some years ago, to the best of my recollection, and I think it was an editorial in the 2892
Chicago Tribune, referring to and discussing the Exeter plant, built, as I understand, by Mr. Cameron.

XQ. 58. In cross question 52, I asked you whether you ever at any time prior to 1897 wrote or published a statement to the effect that the action of a sub-surface irrigation tank or of a tank like that 2893
installed by you at St. Joseph Orphan Asylum, was other than or different from the action of subsidence or precipitation. In your answer to XQ. 53, you state that you have found in The Inland Architect of September, 1895, an article written by you. Do you consider such article as giving the best instance of such a statement as is called for by 2894
XQ. 52, that you have made, prior to 1897? A. So far as I know it is the best statement that I have made regarding the matter inquired into in XQ. 52.

Re-direct examination by Mr. Banning:

R. D.Q. 59. In some of your answers, or rather

2895 some of your publications, you have spoken of screened sewage. Please state fully what you had in mind in using this term, describing the screening action? A. Screened sewage is sewage from which the coarser particles have been held back by any means, as in the case of the use of the dam and
2896 baffle in such plants as I have described, or by the use of an overflow outlet taking the liquid from between the heavier material which has subsided and the lighter material is floating in any tank.

R. D. Q. 60. Please state why you did not put in a plant similar to the one at St. Joseph Orphan Asylum at the World's Columbian Exposition, in
2897 1892-3? A. When the matter of treating the sewage at the World's Columbian Exposition was referred to me with directions to adopt some method, the method used in sub-surface irrigation and in intermittent filtration at St. Joseph Orphan Asylum was suggested to me and was considered by me, but I considered it impracticable because of the im-
2898 mense amount of sub-surface tile, or irrigation area required under the information which I had at that time. Such a scheme would have required a larger acreage than was at my command on the World's Fair ground in the light of the information available at that day. This, taken in connection with the before stated reason for using a
2899 chemical process, namely, that a high degree of purification was not required, excluded the use of a tank and filtration system.

R. D. Q. 61. Please quote into the record, the description of the McCormick plant which you published in The Inland Architect for September, 1895, first stating the character of such publication?

 2900

A. The Inland Architect is a high class archi-
tectural journal which circulates in and around
Chicago, where it is published, and also largely
throughout the United States. The magazine is
published monthly. In examining The Inland Ar-
chitect during recess to see whether I had pub-
lished anything such as called for by XQ. 52, 2901
distinguishing the action in the tanks used with
sub-surface irrigation, and that tank used at St.
Joseph Orphan Asylum in connection with inter-
mittent filtration from the tank ordinarily used
for subsidence or precipitation of sewage I found
an article containing a description of a plant in-
stalled upon my plans at the residence of Cyrus 2902
H. McCormick, Lake Forest, Illinois, in 1895, and
which has been referred to heretofore in this case,
which article was written by me, and in addition
to the description, a discussion of the process oc-
curring in the tank, which distinguishes it abso-
lutely from any process of subsidence or precipi-
tation. The article begins with the description 2903
of a proposed plan in which apparently solution
of the solid matter was first proposed to be fol-
lowed in the same tank by the addition of lime,
a commonly used precipitant in sewage cleans-
ing processes. I have made extracts from this
article, which extracts contrast the process pro-
posed with that I have comonly used known as 2904
intermittent sub-surface irrigation, and the fol-
lowing are the extracts as made:

"In a recent periodical devoted to sanitary work, a plumber in a neighborhood cut up with gulleys and ravines describes an apparatus put in by him which both he and the editor expect to work satisfactorily, but which will surely

2905 cause a nuisance. It consists of two cesspools, or more properly, catch basins, the entire waste from water closets, sinks, etc., in the house discharging into the first catch basin, overflowing from this to the second basin, and from the second overflowing into the ravine. It is proposed to use occasionally, say weekly, a dose of quick-
2906 lime in one basin which it is supposed will prevent disagreeable consequences. Applied in this way the lime will have little effect other than to assist perhaps in sedimentation in the basin, and to deter putrefaction, but the latter will occur later in the ravine. Further, from the apparently large size of the basins there will be but little current to dissolve or carry away in suspension fine particles of matter, so that most of the solids
2907 will be held and must be removed and carried away when in a state of high decomposition.

This description is given to illustrate the evils of all methods of storage of solids and of constant discharge of liquids upon the surface of the ground, and to introduce to attention a system diametrically opposite in which all waste is dissolved or carried forward in finely divided particles in suspension, and is finally disposed of beneath the surface of the ground; final disposi-
2908 tion meaning that the effete material is destroyed and never appears in any form disagreeable to eye or nose, nor can it contaminate the source of water supply. This system, which is technically known as intermittent sub-surface irrigation, has been applied by engineers and sanitarians for twenty years and more, but still remains unknown to people generally.

2909 The conditions which must be observed in the application of the system are that the sewage must be collected in a water tight receiving basin fitted with an automatic siphon by which it is discharged periodically into the tile drains laid with open joints at a depth of from nine to 12 inches below the surface of the ground. The sewage so discharged is the food of certain bacteria which may exist at a slight depth under the

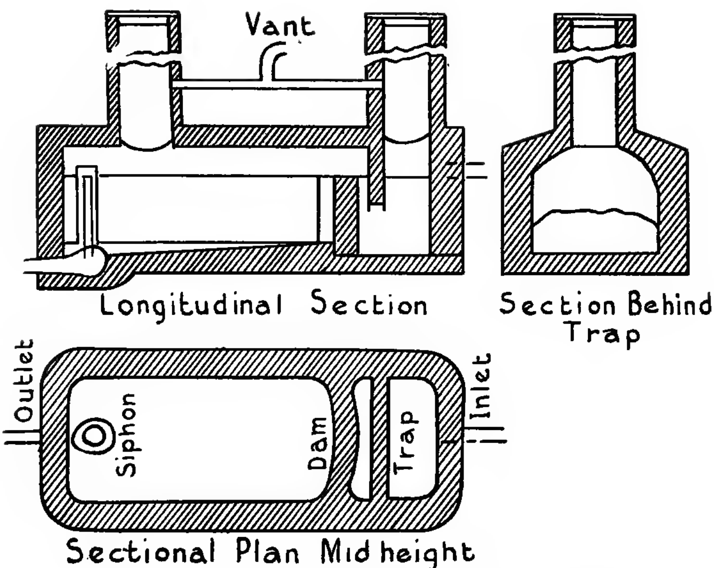

Fig. 3
Flushing Basin Scale 1 inch to 6½ feet.

 2910

surface of the ground and which will grow and live upon the sewage, provided the flow is intermittent so that the soil may become aerated between the doses in order that the bacteria may have the air necessary to their existence. This process is complete and when applied in a different manner to the sewage of towns the water
which flows from the works is innocuous, the or- 2911
ganic matter having been reduced to nitrites and nitrates.

. . . .

A general plan of this system . . is shown in Fig. 1. A section showing relative elevations in the house and lawn is given in Fig. 2. Details of the flushing basin are given in Fig. 3.

In the receiving compartment of the flushing
basin it will be noticed that the space is reduced 2912
to the minimum which will permit a person to get in in case of necessity. This gives reasonable assurance that inflowing water, as from bath or laundry tub, will agitate all contained in the chamber and assist in dissolving or breaking up solids, and it is found that it is never necessary to remove or carry away matter from the basin. The water from all fixtures, except the kitchen
sink, is admitted directly to the basin; in the 2913
sink connection a catch basin is built or a grease interceptor may be set, as the grease is carried through would make it necessary to clean the tile much more frequently. The catch basin is not essential, but as it is customary to use it on house drains in this city its use is continued on disposal systems.

The trap and dam which form the front of the
receiving chamber serve to screen the sewage, 2914
floating matter being held by the trap and heavier by the dam until dissolved or finally divided and held in suspension. Toilet paper should be provided in all water closets where disposal is used, as it readily disintegrates in the water.

. . . .

An apparatus of this kind set in operation will work both summer and winter, as the decomposition of the sewage will prevent freezing, and no particular attention need be given it; no disinfectants or chemical should be used in it, as they would probably be destructive of the bacteria. After ten or a dozen years it may become necessary to lift and clean the tile, but with good material no other repairs or maintenance should be required.

2916 It must not be supposed from the foregoing that a system of drain tile laid to take the overflow of a cesspool just below the ground surface will operate in similar manner. The efficacy of this system depends wholly on the intermittency of its action, allowing aeration of the soil, and upon the complete filling of the tile by the full flush from the basin. A trickling stream from

2917 a cesspool, whether upon the surface of the ground or in the tile immediately under the surface, means a clogged soil, which will become sour with offensive decomposition, and the tile when so used, will soon clog at the points where the trickling stream leaves them, producing a wet spot in the soil above."

Counsel for defendants offers in evidence the article published in The Inland Architect for

2918 September, 1895, quoted by the witness in his foregoing answer and as quoted; and it is stipulated that either party may use such publication for any and all proper purposes at the hearing of this cause.

WILLIAM S. MacHARG.

2919 Adjourned until Tuesday, August 29, 1905, at 10 o'clock A. M.

August 29, 1905, 10 o'clock A. M.; met pursuant to adjournment; present as before.

Henry W. Hill, a witness produced, sworn and examined on the part of defendants, deposes and testifies as follows in answer to questions by Mr. Banning:

Q. 1. Please state your name, age, residence 2921
and occupation. A. My name is Henry W. Hill, my age is 53 years and 6 months, I reside at 235 Michigan Avenue, Chicago, my occupation is that of an architect. I am senior member of the firm of Hill & Woltersdorf. Before that I was junior member of the firm of Bauer & Hill.

Q. 2. In your work as an architect have you 2922
had and do you have anything to do in reference to the construction of sewage disposal plants? A. Yes, sir, we have occasionally, when we build plants outside of the city where no direct sewage disposal can be obtained.

Q. 3. Did your firm construct what is known
as the Altenheim or German Old People's Home 2923
near West Madison Street and the Des Plaines near this city—I mean as architects?

> X. Counsel for complainant objects to the question as calling for matters not set up in defense by the answer, and it is agreed that to avoid repetition it
> may be understood that the same ob- 2924
> jection is made to all questions and answers relating to the Altenheim system.

A. Yes, sir.

Q. 4. When was the Altenheim constructed and what did you have to do with it personally?

A. It was built in the year 1885. I supervised the making of all plans for the building in our office and superintended the construction of the building. When the matter of the disposal of the sewage came up we called in Mr. William S. MacHarg, as an expert, and the plan of the dis-
2926 posal of the sewage was drawn in accordance with his instruction, and it was done under my personal supervision.

Q. 5. If you have the drawings of that sewage disposal plant constructed at the Altenheim here present, will you please identify the same? A. The paper here before me is the identical plan
2927 that was made in our office of that sewage disposal system—it is the original drawing, made under my supervision.

It is admitted by counsel that the drawing identified by the witness in his foregoing answer is the drawing referred to and identified by William S. MacHarg in his answer to question 6, di-
2928 rect examination, and offered in evidence at the end of such answer, and of which a tracing is to be used marked "Defendants' Exhibit Altenheim Plant."

Q. 6. Please explain the construction and operation of the sewage disposal plant illustrated in this drawing identified in your last answer.
2929 A. A brick tank circular in cross section about 32 feet in length and 8 feet in diameter was built below the ground, the top of the tank being about 4 feet below the surface of the ground. The inside of the tank was divided by a dam, brick dam. Each of these compartments had a manhole built of brick extended to the surface of the ground

and covered by an iron manhole cover. All the sewage of the entire buildings was disposed in the northern half of this tank, and the overflow from the northern half of this tank ran into the southern half as liquid, from which it was pumped to an elevated wooden tank outside. This tank
had hose connection. The hose was placed on 2931
a little truck which could be moved around the vegetable garden, and the liquid was used for the irrigation of the vegetable garden mainly. The garden was tiled with lines of 3-inch drain tile about 32 feet apart which emptied into a main 6-inch pipe conducting the filtered liquid which
was conducted to a little pond where several hun- 2932
dred fish were kept. The overflow from this little lake or pond was protected by a weir, so that the fish would not run out, and the overflow ran into a creek which led into the Des Plaines River. The southern tank which contained the liquid was ventilated by means of a 6-inch sewer pipe
to the bottom of the main smoke stack. I will 2933
state this, that a few years thereafter on a cold winter day the man having charge of the tank and the distributing of the liquid pumped it all into one place without distributing it over the area of the vegetable garden, and in some way it flowed directly through the one 3-inch pipe
into the main 6-inch pipe and into the pond, and 2934
the next day the surface of the pond was covered with the dead fish. They were all dead. Thereupon the executive committee of the Altenheim sought permission to make direct sewer connection into the Des Plaines River. They obtained such permit and a 9-inch main sewer was con-

structed into the Des Plaines River, and the filtration was abandoned. A catch basin was built and the main sewer led into the tank and the use of the tank was abandoned. During the use of the tank I had occasion to go to Altenheim quite frequently on account of building different out-
2936 houses, cold storage buildings, etc., and whenever the liquid was pumped from the tank I never saw anything but liquid being discharged from it. I never saw the northern tank being emptied, and to my knowledge it never was emptied—I mean so far as I am aware.

Q. 7. Just how long was that sewage disposal
2937 tank used—from what time to what time? A. From the fall of 1885 to the fall of 1888.

Q. 8. How many people did it serve? A. I should say from 125 to 160 at different times.

Q. 9. Were your position and duties such that you had occasion to know about it during all the time it was in use? A. I was constantly con-
2938 sulted in regard to any alterations which might be necessary to be made on the building or its surroundings regarding the original plan.

Q. 9-a. If it had been cleaned out at different times would you naturally have been consulted about it or known about it? A. I cannot say exactly that I would, although Mr. A. C. Hessing,
2939 who was the president of the institution, generally informed me of all that was going on. He personally took a very great interest in the institution and the gardens and outhouses and everything pertaining to it. Mr. Hessing died several years ago.

Q. 10. Did you know personally in reference

to the character of the liquid or effluent pumped out of that tank? A. I have seen it distributed over the vegetable garden as dung liquid and I have seen it come out of the mouth of the 6-inch pipe at the pond as perfectly clear water; and the fact that there were several hundred fish in
the pond is proof that it was pretty clear water. 2941

Q. 11. Did that tank or plant operate successfully for the purpose for which it was intended during the three years you have referred to, from the fall of 1885 to the fall of 1888? A. Yes, sir, it did.

Q. 12. After constructing that Altenheim plant
did you construct any other of the same kind? 2942
A. Yes, sir.

Q. 13. When ad where, and how did you come to construct the same? A. In the year 1891 we were employed by the St. Benedictine Brothers to build a large college in Bureau County, Illinois, about one mile south of the City of Peru, in La Salle
County, Illinois. The college was intended for the 2943
education of young men. It was also to contain a convent for the monks and a wing for the sisters of the St. Benedictine order. It is called St. Bede College, and we are at the present time constructing another wing to it. It is the intention in the future to make it a very large institution. The
brothers have a piece of ground of several hun- 2944
dred acres, part of which was a large plateau about 150 feet high above the Illinois River, and on this plateau the buildings were to be erected. To the south of the buildings the ground gradually slopes down to the river, and there are ravines leading directly to the river. When the matter of sewage

came up, we decided to lay a 15 inch main sewer pipe down to the ravine, but in order to avoid bad smells resulting therefrom we built a tank similar to the one constructed at Altenheim, of wood.

Q. 14. Please describe in detail the tank referred to in your last answer as constructed at Peru, Illi-
2946 nois, stating just when when it was constructed and put in operation, how it operated, and all about it?

Complainant's counsel objects to the question for the reason that it calls for a matter not set up in the answer, and it is agreed, that, to avoid repetition, the ob-
2947 jection may be understood as made to all questions and answers in regard to the tank and system concerning which the foregoing question is asked.

A. The tank was constructed in the Fall of 1891, and was about 25 feet long, ten feet high and ten feet wide, and built of 3 inch pine plank. It
2948 had in the middle of it a double overflow dam partition. It was placed in the ravine and covered over with ground, and the half tank nearest to the building received the discharge from the main 15 inch pipe. The liquids overflowed into the other half of the tank and from there through an overflow pipe into the ravine. From this latter tank,
2949 a wooden ventilator was built in direct communication with the air above. So far as I know, the system has worked with the greatest satisfaction. I have never heard any complaints, and not longer than six weeks ago when I was at the college superintending the erection of the present wing to the building I personally went to the tank, saw the

overflow from it, and did not notice any objectionable odors.

Q. 15. How many people has that tank at Peru served? A. About two hundred and fifty.

Q. 16. And that has been the case ever since the plant was constructed? A. When the college was opened, they probably had a few less, may be one 2951
hundred and fifty.

Q. 17. As I understand you, that plant was constructed and put in use in the Fall of 1891, and has been in use ever since, serving from 150 people at first to 250 at the present time. Is all this correct? A. Yes, sir.

Q. 18. Is that a closed tank? A. Yes, sir, a 2952
closed tank and covered with several feet of earth on top of it.

Q. 19. Do you know whether it was ever cleaned out or not? A. I do not.

Q. 20. Do you know how long the sewage is allowed to remain in it? A. Why it is constantly flowing into it, and constantly flowing from it into 2953
the ravine.

Q. 21. What I mean is, how long would it take to fill the tank if it were empty, and how long would it take to empty it if it were full, the inflow and outflow respectively being at the normal rate? A. The tank nearest to the building never empties, the contents are withheld by the partition 2954
dam built in the center of it and the depth is about two-thirds the height from the bottom, and the overflow into the ravine is about at the same level, it might be an inch or two lower, but it is kept that much filled to preserve the wood. It is constantly moist. Suppose the tank should be entirely

2955

empty and without rain it would take about seven and a half days to fill the tank from the sewage and waste water used at the buildings, each compartment holding about seven thousand five hundred gallons. When the tank is in operation, the outflow is about equal to the inflow, but the tanks
2956 are about two-thirds filled constantly.

> Complainant's counsel objects to the foregoing answer, and to any similar answers made or that may be made by the witness with respect to the tank in question as incompetent, not being the best evidence as to the construction of the
> 2957 tank, since the tank itself is in existence and is capable of reproduction by accurate drawings.

Q. 22. How are the inflow and outflow arranged in that tank at Peru? A. The bottom of the inlet is about two-thirds the height from the bottom of the tank, and the outflow of the other tank is a
2958 couple of inches lower.

Q. 23. In answer to question 6 you have stated that " the inside of the tank was divided by a dam, brick dam." Referring to the drawing "Defendants Exhibit, Altenheim Plant," please indicate this dam by putting on reference letters, and state
2959 whether or not it was a single dam and what the other line on the drawing indicates? A. The dam I have indicated by the letter " X " and about a foot away from it was the trap wall which I have indicated by the letter " Y."

Q. 24. Was that same construction used in the tank at Peru? A. Yes, sir.

Q. 25. Was that tank at Peru used publicly in
the ordinary course and for the ordinary purpose
of such a construction? A. It has been used ever
since for that purpose. The tank there was built
by our regular carpenter, Mr. Heine, the sewage
connection was made by Mr. Birkenshaw, both
since deceased. At that time Mr. Birenshaw was a 2961
sewer builder in Chicago. They all knew about
it, as well as the abbot of the institution.

Q. 26. Please look at the article entitled "St.
Joseph's Asylum Sewage Irrigation Plant," on
page 386 of the Engineering and Building Record
of November 30, 1889, quoted in Mr. MacHarg's
answer to question 8 of his deposition in this cause, 2962
and state whether it describes and shows the same
form of sewage disposal tank that you constructed
at the Altenheim, near Chicago, and at the St.
Bede College, near Peru, Illinois, as stated in your
previous answers? A. The plan and section of the
sewage disposal tank of the St. Joseph's Orphan
Asylum, before me, is a facsimile of the tank built 2963
at Altenheim, except that the tanks at Altenheim
were larger. It is also a facsimile of idea to the
tank built at St. Bede's College, Peru, with the
difference, as stated before that the tank at Peru is
built of wood and is square in cross section, in-
stead of circular.

Cross-examination by Mr. Fisher: 2964

Counsel for complainant, without waiving the objections hereinbefore made, but insisting thereon, cross examines the witness as follows:

XQ. 27. How many sewage disposal systems
have you constructed or caused to be constructed,

in which a sewage tank was employed? A. The Altenheim and the St. Bede College.

XQ. 28. Are these the only sewage disposal systems that you have built or caused to be built in which tanks were employed? A. Yes, sir.

XQ. 29. Have you had occasion, since 1885, to
2966 design, or build, or instal any sewage disposal systems other than those mentioned by you? A. No, sir, all the other buildings erected by us since that time were sewered into existing systems.

XQ. 30. Have you had occasion, since 1885, to design or erect any large buildings located away from and inaccessible to the sewage systems of
2967 cities? A. Only the St. Bede College, in 1891—none since.

XQ. 31. Did you design the building for the Altenheim? A. Yes, sir.

XQ. 32. Your work was the regular work of an architect for that institution, was it not? A. Yes, sir.

2968 XQ. 33. Did you design the sewage disposal system for the Altenheim? A. No, sir.

XQ. 34. The work that you had to do, so far as concerned the sewage disposal system for the Altenheim was to carry out the plant of the person who designed that system, was it not? A. We engaged Mr. MacHarg at that time to plan the sew-
2969 age disposal system. The executive committee of the Altenheim entered into contract with Mr. MacHarg to build the system and it was built under our supervision.

XQ. 35. But you had nothing to do with the direction or superintendence of the operation of the sewage disposal system of the Altenheim? A. Yes,

 2970

sir, we had. We had general supervision, and be-
fore we issued the final certificate of payment to
Mr. MacHarg we were satisfied that the system
was working as contracted for. But we had noth-
ing to do with the further operation of the plant.
We gave no instructions in regard to operating it.

XQ. 36. Referring to the drawing "Defendants 2971
Exhibit, Altenheim Plant," will you please indi-
cate by reference letters upon such drawing, the
ventilating pipe that led from the sewage disposal
tank to the smoke stack? A. I will write down the
word "vent" on that pipe.

XQ. 37. I observe that the pipe which you have
designated as the "vent" pipe on the exhibit draw- 2972
ing last referred to is divided adjacent to the tank.
Will you please state what this means? A. The
Y branch shown on the plan, shows a vent connec-
tion for each of the tanks.

XQ. 38. Do you mean that each section of the
sewage disposal t ank was connected by a branch
vent pipe to the main vent pipe that led to the bot- 2973
tom of the smoke stack? A. Yes, sir.

XQ. 39. What was the size of these branch vent
pipes that connected the two sections of the tank
to the main vent pipe? A. They were 4 inch pipes
connecting into one 6 inch pipe.

XQ. 40. State if you know what was the height
of the dam that divided the Altenheim tank into 2974
two sections? A. Well I could not answer that
correctly, because I don't remember that any more.

XQ. 41. State if you know the size of the inlet
pipe that delivered sewage into the Altenheim tank?
A. It was a 6 inch pipe, if I remember right.

XQ. 42. Do you know how far the inlet pipe of

2975 the Altenheim tank was located above the level of the liquid within the tank? A. I couldn't swear to that exactly, but naturally it was on a level or one or two inches higher than the overflow dam for the purpose that it would have to be above it.

XQ. 43. In the Altenheim system, did the tank
2976 receive the rain water from the roof of the building? A. No, sir. The rain water ran into a separate cistern, which was under the laundry, and the water was used for washing purposes. The overflow of that cistern ran into a pond.

XQ. 44. How often did you see the liquid from the tank at Altenheim pumped or distributed
2977 over the vegetable garden? A. Well, now I did not keep track of that, but I saw it on and off, may be three or four times.

XQ. 45. When you observed the distribution onto the vegetable garden of the liquid from the Altenheim tank, did the liquid appear at all thick or simply like muddy water? A. More like muddy
2978 water, like muddy clay water.

XQ. 46. Did you examine this liquid closely enough to see how finely the suspended matter therein was divided or macerated? A. I did not.

XQ. 47. Did you ever observe the pumping out of the Altenheim tank? A. Yes, sir.

XQ. 48. In what way was this done? A. It was
2979 done with a hand pump.

XQ. 49. In examining the liquid that was pumped out of the Altenheim tank, did the matter carried thereby in suspension seem to be very finely divided? A. I never examined the liquid closely. I only saw it at a distance of from four to eight or ten feet away. It seemed like regular muddy water.

 2980

XQ. 50. How far below the surface of the ground were the drain tiles located in the Altenheim system? A. About two and a half feet below the surface of the ground.

XQ. 51. How was the liquid from the tank distributed over the surface of the ground? A. Along-
side of the brick tank was a wooden circular tank 2981
elevated on a wooden support about 8 feet above the ground and the liquid was pumped into this tank, and by its own gravity was filtered over the ground by means of a hose. The man using the hose distributed it wherever he saw fit.

XQ. 52. And in distributing this liquid from the
tank the person using the hose directed the flow 2982
uniformly over the garden, did he? A. Yes, sir.

XQ. 53. Did you ever look into the Altenheim tank and examine its contents after the tank was placed in operation? A. I have not.

XQ. 54. When the direct connection was made with the Des Plaines River by means of the sewer
pipe at the Altenheim, what became of the tank? 2983
A. It was removed and the ground filled up.

XQ. 55. How long was it after the Altenheim tank was put in operation before you gave Mr. MacHarg his final certificate? A. That, I couldn't tell, without looking at the books. We generally pay the final certificate in about thirty days after
the work is completed, and I judge that is what 2984
happened in that case. I feel quite sure it was within thirty days.

XQ. 56. Did you observe whether the liquid pumped from the Altenheim tank left a yellowish deposit in the garden on which it was distributed by the hose? A. Apparently it did not leave anything.

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XQ. 57. Did you not observe that the effect upon the garden was what you would naturally expect to see from spraying or distributing upon a garden yellowish muddy water? A. I know that the vegetables that were raised there, the corn and onions, were of a profound growth.

2986 XQ. 58. Do you know how often the Altenheim tank was pumped out? A. I do not know. I should judge about every second day. I have no way of knowing.

XQ. 59. About how often did you examine the Altenheim tank after it was placed in service? A. I had no occasion to examine it at all.

2987 XQ. 60. How often did you see the operation of pumping sewage from the Altenheim tank during the first three months after the tank was placed in service? A. May be twice.

XQ. 61. In the sewage disposal system which you installed at the college of the Benedictine order at Peru, Illinois, was the tank connected
2988 with the down spouts that received rain water from the roof? A. Yes, sir.

XQ. 62. What was the area of the roofs of the buildings from which the down spouts led to the sewage disposal tank? A. About fifteen thousand square feet of roof.

XQ. 63. Did you make any drawings from which
2989 the sewage disposal system at Peru was installed? A. Yes, sir.

XQ. 64. What became of such drawings, and where are they now? A. I have looked over our drawings at the office this noon, and yet I cannot find the drawing of the tank.

XQ. 65. How far was the tank at Peru located from the building? A. I should judge about four hundred feet—from three to four hundred feet, and the grade down from the building to the tank must have been from 25 to 30 feet.

XQ. 66. What was the size of the pipe that conducted the sewage from the buildings to the tank at Peru? A. Fifteen inches internal diameter. It 2991
was of vitrified socket sewer pipe. The joints were cemented.

XQ. 67. How far above the level of the sewage in the tank did this fifteen inch delivery pipe discharge? A. It was about seven feet above the bottom of the tank.

XQ. 68. In what way was the Perù tank cov- 2992
ered? A. It was covered with earth which was placed on top of the boards that formed the roof of the tank.

XQ. 69. How many openings were there in the roof of the Peru tank? A. As far as I remember there was one square pipe or box, twelve inches square about from the outer tank open to the air. 2993

XQ. 70. If I understand your testimony correctly, there was a straight run of fifteen inch sewer pipe from the buildings to the sewage disposal tank at Perù, is that correct? A. Yes, sir.

XQ. 71. There was no catch basin or chamber of any kind interposed between the buildings and the tank, were there? A. There was one manhole 2994
where several of the main branches ran into the 15-inch pipe near the building, but that was no catch basin. There was no trap in it. It was merely for the purpose of being able to go down to the bottom of the sewer and rod the branches for the purpose of cleaning them if it should become necessary, and

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this manhole was within the building groups and
from there the fifteen-inch pipe ran uninterruptedly
to the tank.

XQ. 72. At what point of the Peru tank did the
15-inch delivery pipe enter? A. It was at the end
about seven feet above the bottom of the tank.

2996 XQ. 73. What pipes, if any, were there leading
from the Peru tank? A. Just the spout; the over-
flow spout.

XQ. 74. At what point of the tank was this over-
flow spout located? A. It was probably an inch
or two below the inlet pipe at the opposite end of
the tank.

2997 XQ. 75. How far into the tank did the inlet pipe
extend? A. Probably a couple of inches inside.

XQ. 76. What was the size of the outlet spout
of the Peru tank? A. About the same size as the
inlet.

XQ. 77. Were all the closets and discharges
2998 from the buildings connected with the sewer pipe
that led into this Peru tank?. A. Yes, sir. All
plumbing fixtures of whatever kind, also the blow
off pipes from the boiler and all conductor pipes
from the roof.

XQ. 78. What provision was made for obtaining
access to the interior of the Peru tank for the pur-
2999 pose of cleaning the tank? A. There was a man-
hole left in it in the top of it but if it was ever
opened I don't know.

XQ. 79. Where was that manhole located? A.
About in the middle of the tank.

XQ. 80. What was the size of the manhole? A.
Eighteen inches square.

XQ. 81. Did that manhole communicate with the receiving end of the tank? A. Yes, sir.

XQ. 82. How much earth covered the Peru tank? A. I should say about two feet.

XQ. 83. With what did the discharge spout of the Peru tank communicate? A. It emptied into the ravine. 3001

XQ. 84. What was the length of the discharge spout? A. I don't think it was more than one length of 15-inch pipe.

XQ. 85. Will you please describe the discharge spout more accurately and just how the effluent passed therefrom? A. The spout was a 2-foot section pipe, sewer pipe, vitrified pipe same as used 3002
for the inlet, and just discharged into the ravine. We packed the earth up around the outside.

XQ. 86. If I understand your deposition correctly, it is that the discharge end of the Peru tank was provided with a round hole, into which was set one end of a 2-foot section of vitrified sewer pipe that constituted the discharge spout of the tank. 3003
Is that correct? A. That is correct.

XQ. 87. Did you ever examine the interior of the Peru tank after it was placed in operation? A. I have not.

XQ. 88. Do you know how often the Peru tank was cleaned? A. So far as I know, it was never cleaned. 3004

XQ. 89. The fact is, I suppose, that you know nothing about whether the tank was cleaned or not? A. That's right.

XQ. 90. What became of the effluent from the Peru tank? A. It ran into the ravine and from there it passed to the Illinois River.

XQ. 91. When did you last inquire or learn
about the operation of the Peru tank? A. Within
two months I was out there and where the tank
was placed you don't see anything except the little
wooden ventilator and the moisture in the ravine.
The grass grows over it and weeds and shrubs and
3006 so on.

XQ. 92. Was the discharge spout of the tank so
that you could see any liquid passing therefrom?
A. I did not particularly look for the discharge
spout. The bushes and grass were so grown over
it. I saw in the ravine a little moisture.

XQ. 93. When did you last observe the liquid
3007 passing from the discharge spout of the Peru tank?
A. Not since it was completed. When the sewage
system was started I saw the liquid flowing from
the discharge spout, but since that time I have
never observed it.

XQ. 94. How long was it after the Peru tank
was built before you saw liquid passing from the
3008 discharge spout? A. I saw it when the dedication
of the institution took place. I do not remember
exactly how long that was after the tank was built.
It was several months.

XQ. 95. But you never observed the liquid flowing from the tank except upon that one occasion
mentioned by you. Is that correct? A. Yes, sir.

3009 XQ. 96. As I understand, you never made any
inquiries about the operation of the Peru tank,
simply because you never heard any complaints in
regard to its operation. Is that correct? A. This
spring when I came out to Peru in connection with
the erection of the new wing, I did ask the brothers
there how the sewage system worked, and they said
"first rate," and never made any complaint.

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XQ. 97. Have you at your office, or within your possession, any specification or description showing the exact dimensions of the Peru tank? A. No, sir.

XQ. 98. Then your testimony with respect to this tank is entirely from recollection, is it not? A. That is right—from recollection. 3011

XQ. 99. What was the character of the water supply system at the Benedictine College at Peru? A. An artesian well was driven to a depth of more than 2500 feet and the water raised to within several feet from the surface; and by means of a steam pump the water is pumped into a large receiving tank about 60 feet high above the ground. The supply is taken from that. 3012

XQ. 100. In designing the Peru tank and the sewage system how many gallons of sewage outflow did you estimate per capita? A. The part of the building completed at the present time is only one-third of what it will be some time hereafter; therefore we made the main sewer pipe a 15-inch pipe 3013 which is abundant for a small town, and as the outflow of the tank is as large as the inflow we didn't care for the size of the tank. We didn't take that into consideration because the outflow is as large as the inflow.

XQ. 101. Have you made any changes in the sewage disposal system of the Benedictine college 3014 at Peru since you first planned that system? A. No, sir.

XQ. 102. If I understand your testimony correctly, it is that you planned the sewage disposal system at the Benedictine college at Peru, with a view to a largely increased number of users of such

3015

system, and you regarded the sewer pipe as a proper size to take care of a large increase in the number of persons using the system and you regarded the tank as a proper size for the sewage that could be delivered through the 15-inch pipe. Is that correct? A. Yes, sir.

3016 XQ. 103. Did you ever make any tests to determine the amount of sewage passing into or from the tank at Peru? A. I have not.

XQ. 104. So that you have no way of determining just how much sewage passed to and from the tank, is that correct? A. That is correct. In my judgment there was more rain water passing
3017 thorugh it in the year than sewage.

XQ. 105. What do you understand to be the character and extent of the flow to the tank of the Peru system in event of a severe rain storm? A. Well, last spring when we took our levels for the new wing, I wanted to know the depth of the main sewer in regard to the discharge of the subdrainage
3018 water and for that reason I opened the manhole opening, and there was then in the main sewer about a flow of five inches of liquid when I had it opened in this 15-inch pipe. It was not raining that day. That flow was from the normal action of the system. In a heavy rainstorm I should judge that the 15-inch pipe would be filled to its full ca-
3019 pacity—pretty near. I mean with the present roof area. That would clean flush the tank. I may have exaggerated the filling of the 15-inch pipe during a heavy rain storm because I have not seen it and a 15-inch pipe is a very large pipe, there being mains in the Chicago streets, for instance, Wabash Ave. and down town having only a 12-inch

sewer and it having to take care of a great many more roofs than the Peru college roof.

XQ. 106. To what extent do you think an ordinary heavy rainstorm would flush the tank of the Peru college system? A. Well, gentlemen that would only be presumption on my part to make a statement of that kind. 3021

XQ. 107. With the 15-inch pipe full or approximately full, and with the fall of twenty-five feet between the buildings and the tank, what do you think would be the flow of liquid into the tank? In answering this question you may assume that the rainfall is one inch in an hour? A. With a rainfall of one inch per hour the amount of rain 3022
that would be brought down by the 15-inch sewer would be equal to 1255 cubic feet, and the contents of the tank being two-thirds of one thousand, or about 666 cubic feet, would mean that the tank would be filled twice or emptied twice during an hour.

XQ. 108. Was the Peru tank built of tongued 3023
or grooved lumber? A. Yes, sir.

XQ. 109. Was the tank lined in any way? A. No, sir.

XQ. 110. Were the joints of the boards caulked? A. No, sir.

XQ. 111. What was the character of the soil in which the tank at Peru was embedded? A. Yel- 3024
lowish clay.

Re-direct examination by Mr. Banning.

R-d-Q. 112. Referring to your answer to cross-question 57, was any deposit made on the vegetable garden from the effluent of the Altenheim tank—that is, what was the appearance of the garden in this respect? A. It did not seem to leave any sediment on the ground, and did not change the color or appearance of the ground.

R-d-Q. 113. Was there any odor from the effluent of that Altenheim tank? A. It was not perfume exactly that came from it. It had a kind of a dis-
3026 agreeable smell or odor.

R-d-Q. 114. Did you say that the effluent of that tank was like roily or muddy water? A. It had a yellowish tint rather than a white tint. It was more roily water, with a yellowish tint.

R-d-Q. 115. What was your object in using the tank you have described at St. Bede College, Peru,
3027 Illinois, why did you not discharge the sewage directly into the ravine?

> Complainant's counsel objects to the question as immaterial and as not proper redirect examination.

A. My judgment was that if we discharge the sewage directly by the 15-inch pipe into the ravine
3028 that in that case solid matter would be discharged which would become a nuisance and I interposed the tank to get rid of the solids as it had been a success at Altenheim.

R-d-Q. 116. How did you expect to get rid of the solids by the use of that tank?

3029 Same objection.

A. Mr. MacHarg had explained to me previous to the adoption of the system at Altenheim that the solid matter would be consumed at the first tank and that the liquid could be pumped away, and in this case at Peru it flowed away on its own gravity.

Complainant's counsel further objects to the answer as being hearsay and incompetent.

R-d-Q. 117. What was the character of the effluent from that tank at Peru—was it clear or roily? A. It was roily.

R-d-Q. 118. In that tank did the discharge spout 3031
permit full aeration by discharging into the ravine? A. It was open, perfectly open, 15 inches in diameter at the one end and 12 inches at the top so a circulation of air could take place through the tank.

R-d-Q. 119. But what I mean is, was the effluent
subjected to aeration after leaving the tank? A. 3032
Yes it was open to the air.

R-d-Q. 120. Was there any odor from the moisture of that tank when you saw it within the last few months? A. Not perceptible.

R-d-Q. 121. How about the odor the first time you saw the tank in operation? A. I do not re-
member. 3033

R-d-Q. 122. What did you say was the fall of that ravine from the tank to the river? A. About 120 feet. The distance must have been at least 2500 feet if not more.

R-d-Q. 123. Was the manhole you have referred to in connection covered with earth or not? A.
Yes, it was covered with earth. 3034

R-d-Q. 124. Was there any vent on the receiving of that Peru tank? A. The 15-inch pipe in itself would make a first-class ventilator for that part of the tank, as it is directly open to the air by means of the different conductor pipes, and there was no other vent but that pipe.

Recross examination by Mr. Fisher, without waiving objections heretofore noted.

R-XQ. 125. Will you please state more exactly than you have done just how the receiving section of the Peru tank was separated from the discharge section? A. It was separated by means of a trap
3036 partition and an overflow dam.

R-XQ. 126. At the time you installed the tank at the Benedictine college, at Peru, was it not your understanding that the sewage entering the tank would be churned up or agitated, and hence would pass away with the liquid from the discharge end of the tank? A. Yes, I think that with heavy rains
3037 that part of the solid matter would dissolve into minute bodies and pass away with the liquid. I have no knowledge of it, however, but guess so.

R-XQ. 127. And was it not your understanding as the result of your talk with Mr. MacHarg previous to the installation of the Altenheim tank that such would be the action in that tank at Altenheim?
3038 A. At Altenheim the rain water did not flow into it.

R-XQ. 128. But did not you understand it with respect to the Altenheim tank that the incoming sewage at the receiving end of the tank would be churned up or agitated so that solid matter would be broken up into such exceedingly small particles
3039 that it could be pumped away with the liquid from the discharge section of the tank? A. No I did not understand it that way when we were building it. I understood that the time would come when the solid matter would gather and would be taken out at the manhole for that purpose in the tank. I never believed that all the solid matter would be

thoroughly dissolved. That was at the time we installed the tank at Altenheim.

R-XQ. 129. But you understood by the statement which you say Mr. MacHarg made to you previous to the adoption of the system at Altenheim that the solid matter would be consumed (as mentioned in your answer to R-d-Q 116), that the 3041 solid matter entering the receiving end of the tank would be churned up or macerated so that part of it would settle in the receiving tank to be subsequently removed while the remainder in suspended condition would pass into the discharge end of the tank from which it could be pumped. Is that correct? A. Yes, it is correct. 3042

R-XQ. 130. Was the partition that extended upward from the bottom of the Peru tank as high or higher than the outlet opening of that tank? A. It was about at the same level.

Re-direct examination by Mr. Banning.

R-d-Q. 131. Referring to your answer to R-XQ. 129, did you understand from Mr. MacHarg's statement that there was any churning or agitation of 3043 the solid matter entering the receiving end of the Altenheim tank or that the solid matter was dissolved by the natural action of the liquid itself or things contained therein?

The question is objected to as leading. 3044

A. I don't remember that the word "churning" was used, but I remember that Mr. MacHarg explained that the solid matter would be dissolved by the liquid as the liquid of course comes in in much larger quantities than the solid matter, but I also understood that it might happen that the

3045 solids would have to be removed from time to time. I understood it so at that time.

R-d-Q. 132. Do you mean that you understood from Mr. MacHarg that in practical work a large portion of the solids would be gotten rid of by being held in the same tank with the liquid, but that you
3046 do not remember exactly how he explained they were to be gotten rid of?

Objected to as leading.

A. Yes, that is right.

Recross examination by Mr. Fisher.

R-XQ. 133. And that was the idea that you
3047 wanted to convey by your answer to R-d-Q. 116 where you stated that Mr. MacHarg explained "that the solid matter would be consumed at the first tank," is that correct. A. Yes, sir.

HENRY W. HILL.

Adjourned till Thursday, August 31, 1905, at 10 o'clock A. M.

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BENEZETTE WILLIAMS. 3050

Thursday, August 31, 1905, ten o'clock A. M.; met pursuant to adjournment; present at before.

Benezette Williams, a witness produced, sworn and examined on the part of defendants, deposes and testifies as follows, in answer to questions by Mr. Banning: 3051

Q. 1. State your name, age, residence, and occupation? A. Benezette Williams, 60 years old; residence, Western Springs, Illinois; office, 153 La Salle Street, Chicago; occupation, civil engineer.

Q. 2. Please state what experience you have had as an engineer, particularly in the line of sanitary work? A. My greatest experience has been in 3052
the line of hydraulic work in a general way, and which has embraced as a matter of fact a good deal of sanitary work, that is the sewerage and sewage disposal for cities and towns, as well as private house drainage. I graduated at the University of Michigan in 1869. I began my first employment in sewerage work in 1872, in the City of Chicago, and 3053
for the City of Chicago. I have been employed in sewerage work in almost all of what were once the surrounding towns of Chicago, as Lake View, Hyde Park, Town of Lake, Village of La Grange, Western Springs, and I designed and practically superintended the construction of the sewerage system of the Town of Pullman, which involved a 3054
pumping plant and land disposal of the sewage. I have also designed sewerage systems for many cities throughout the country— Saginaw, La- Crosse, Wisconsin; Council Bluffs, Iowa; Decatur, Illinois; Marion, Indiana; Seattle, Washington; what was Fair Haven, Washington, now a part of Bel-

3055

lingham, Aberdeen, South Dakota, and probably a number of other places which I do not think of at present. I was also employed after I left the regular service of the City of Chicago, in 1886, on the commission for the sewage disposal of the City of Chicago, of which Rudolph Hering was the chief
3056 engineer; and I was subsequently chief engineer of the sanitary district.

Q. 3. Have you examined and do you understand the Cameron, Commin and Martin patent, No. 634,423, dated October 3, 1899, sued on in this cause, and do you understand the apparatus and process described and claimed therein? A. I have ex-
3057 amined the patent referred to and I understand its main features and method of sewage treatment therein described.

Q. 4. Please state what particular methods of sewage disposal you employed prior to 1897, and particularly whether you had anything to do with what is commonly spoken of as the Waring method,
3058 the same being the method employed by Colonel Waring and his associates? A. As applied to towns or cities, the only actual method of sewage disposal which I had experience in prior to that time consisted in discharge into water courses, or bodies of water and land disposal except that in connection with the main
3059 drainage of Chicago, the commission made a study of all known methods of sewage disposal. As applied to isolated houses, I have had experience with one phase of land disposal known as sub-surface irrigation, and in connection therewith became familiar with and employed the method developed by Colonel George E. Waring, Jr., and others. I also

was familiar with, and employed in Pullman, what was known as the Waring System of Sewerage, that is a system in which the sewage is separated from storm water, or kept separate, and disposed of without storm water.

Q. 5. Please describe the Waring system in de-
tail as used prior to 1897, with particular reference 3061
to its bearing on the process and apparatus describ-
ed in the Cameron patent sued on in this cause. In
this connection you may also explain in detail any
other process or apparatus of which you had per-
sonal knowledge prior to 1897, and which you may
consider in any way material.

> Complainant's counsel objects to the 3062
> question and any answer thereto so far as
> such answer may relate to matters of de-
> fense not set up in defendants' answer;
> and it is agreed that this objection may,
> to avoid repetition, be understood as made
> to any other questions and answers of
> similar character. 3063

A. Before describing the apparatus used as a
part of the system of sub-surface irrigation de-
veloped by Colonel Waring and others, it may be
well to observe that the principle or biological
method of sewage purification by means of the
work of bacteria which reduce or decompose the
organic matter contained in sewage from one form 3064
to another, was in a sense discovered through the
tentative work and experiments of Colonel Waring
and others. In order that the whole subject may
be presented consecutively in the manner in which
the development took place, and that the several
steps leading up to the discovery and application

of what is now termed "septic action" may be
fully understood, and to show that the develop-
ment of the elements of septic sewage disposal was
made during the professional career of Colonel
Waring, mainly by himself, though with certain
inventions and applications of methods made by
3066 others, I refer to the various writings of Colonel
Waring. The most complete historical record of
this development and the description of the meth-
ods used is to be found in such writings. It is suf-
ficient, however, to trace this development in
Colonel Waring's principal work, "Sewage and
Land Drainage," which was published in first
3067 edition in 1889. This historical record contained
in the work referred to, shows that septic action
as it relates to sewage disposal was understood and
put into application with an apparatus which, in
its main features, is a counterpart of the Cameron
Septic Tank, some years prior to 1889, the date
of the publication of this work. It may be observ-
3068 ed that not only was this method of sewage dis-
posal understood, so far as the results were con-
cerned, but that it was attributed to bacterial ac-
tion. This record shows that it was at first sup-
posed that bacterial action would only take place
in the presence of oxygen, but it was discovered by
Colonel Waring in his experiments or in the ap-
3069 plication of his methods that the suspended solids
of the sewage were decomposed in chambers from
which light and air were excluded, and which were
variously called by himself and others "grease
traps," "settling basins," or "intercepting cham-
bers." To bring out the force of this statement,
a number of quotations will be made from the rec-

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ord referred to, which are indicative of the gradual growth or the step by step process by which he arrived at his final conclusion or result. The following quotation from page 15 of Sewerage and Land Disposal, under the head of "Bacteria" is a recognition of the fact that bacteria are the cause directly or indirectly of all organic decomposition. 3071

"As the study of the micro-organisms has gone on many of these notions have been shown to be unfounded. It is still too early to speak positively as with scientific accuracy on any department of the subject, but enough is known to justify a much less alarming view of the case. Indeed, there can be no doubt that not only are bacteria as a class beneficial and not hurtful, but that their development and activity lies at the root 3072
of all fertility of the soil and of the ability of the earth to support vegetable and animal life. It is not to be doubted that waste organic matter before it can again become food for plants must be subjected to a process of disturbance which, formerly supposed to be due to chemical oxidation, is now known to be due to the action of bacteria."

In speaking generally of sewage disposal, on 3073
page 233, Colonel Waring says:

"It is these processes which we must employ in the successful destruction of all organic waste other than such as is consumed by fire. They go on in spite of us. We may delay them or conceal them, or change the seat of their activity. We may hasten them, or modify them, but we cannot prevent them. Sooner or later by combustion, 3074
by direct putrefaction or by indirect fermentation they will work their destructive end, bringing all matter that has once lived again back to the domain of life. The cycle is unceasing, and according to our action concerning it, or according to our neglect, will its influence be good or bad. Thus far we are not quite sure how our action should be guided."

Colonel Waring has the following to say, on pages 235 and 236, with reference to the processes which occur in land purification of sewage matter:

,"Precisely what change they undergo and in what way is not fully determined, but we are
3076 justified by investigations already made in accepting a theory which accounts for the remarkable results with which we are familiar, and which is in accordance with such knowledge as we now possess. The engineers, chemists and biologists who have made a study of the works at Gennevilliers show good reason for their belief that the organic matter thus decomposed becomes food for the bacteria of putrefaction and nitro-
3077 faction, which are abundant in all soils containing organic matter, and to which the air has free access. They believe that in a porous soil suitably constituted and containing the impurities of town sewage, these bacteria multiply enormously, consuming the pabulum presented to them, combining with it the oxygen in the air with which the soil is pervaded, and reducing it entirely to such organic compounds as constitute the food of plants available for the uses of vege-
3078 tation during the proper season and readily removed in solution by the water percolating through the ground at all times. The complete destruction of these wastes as organic matter is effected before they are taken up by plants and before they can be removed from their contact with the soil by the water descending through it. . . . . . . As long ago as 1876 Pasteur in
3079 his studies on fermentation indicated clearly the difference between decomposition taking place with full exposure to the air, and that going on in liquids from which air was entirely or mainly excluded. It is now well understood that the bacterium termo on which we so largely depend for the destruction of organic matter in sewage is not active except in the presence of air. In the experiments carried on in the laboratory of

the Surgeon General's office in Washington it was found that various specific germs planted in rows on gelatine plates could be identified and studied throughout their development so long as the growth of the bacterium termo could be excluded, but the germ of this taking root on the plate it grew rapidly in all directions and seemed entirely to destroy all of the specific cultures. The 3081
inference therefore seems not unreasonable that under suitable conditions of seeding, pabulum and aeration as in the surface soil the processes of putrefaction will destroy germs which, if existing beyond the reach of these processes, that is, in a position where atmospheric air is excluded, may remain unharmed and may retain their power for mischief."

On page 237, Colonel Waring quotes from a 3082
paper by R. Warrington, read at the Montreal meeting of British Association for the Advancement of Science in 1884, as showing the then existing knowledge of bacterial reduction of organic compounds:

"Up to the year 1877 it was supposed that the
formation of nitrates from ammonia and from 3083
organic compounds containing nitrogen was the result of atmospheric oxidation. The belief had long existed and had been a favorite one with Liebeg and his followers that the oxygen of the air contained in the soil was condensed on the surface of its particles, and was renewed by the fresh access of air as rapidly as it was taken up by the process of oxidation in which it was supposed to be especially active. In the year named 3084
Schloessing and Muntz showed that nitrofaction as studied in the action of soils on sewage is due to an organized ferment. Later experiments of these chemists and of others have sustained this theory. . . . . The oxidation of the nitrogenious organic matter of river water is still spoken of by some as determined by mere contact with atmospheric oxygen and the agitation

of the water with air as a certain means of effecting oxidation; while by others the oxidation of nitrogenous organic matter in a river is denied, simply because free contact with air is not alone sufficient to produce oxidation."

Though there are hints of bacterial disintegration of the organic matter contained in sewage
3086 taking place with and without the presence of oxygen in some of the foregoing quotations, it is under the head of the Disposal of House Wastes, and after having used for some time a grease trap or intercepting chamber in connection with a flush tank for sub-surface irrigation that full recognition is made of the fact that bacteria act in clos-
3087 ed besins from which light and air have been excluded. As bearing upon this statement, quotations are made from pages 287, 288, 289 and 290 of Sewerage and Land Drainage:

"Wherever there is a considerable amount of land available, not too near occupied buildings, the safest and best means of disposal is by subsurface irrigation, being in a smaller way the
3088 same system as is recommended in the chapter on Sewage Disposal in the case of towns. Where this means is adopted it is important to collect the sewage in a vessel from which it may be intermittently discharged in volume sufficiently to cover a considerable area of land. The ordinary settling basin and flush tank described below accomplish this purpose in a satisfactory manner. . . . . . . This system originated, as far as
3089 we know, with the Rev. Henry Moule, of England, the inventor of the earth closet, who published a description of its application in 1868. He had found that the use of the earth closet was objected to for the reason that it fails to provide for the disposal of the liquid wastes of the house, leaving it necessary that a cesspool or sewer should be resorted to for this purpose, which might as well be used in connection with water

closets. He tried the experiment of laying an open jointed tile drain a few inches below the surface of the ground along the foot of a trellis covered with grape vines. The result was a vigorous growth and improved fruitage of the vines and an inoffensive and inoccuous disposal of the waste liquids.

A few years later Mr. Rogers Field made use 3091
of the same system in connection with the drainage of houses at Leatherhead, supplementing the drain with a flush tank arranged to hold back the flow until it became full, and then to discharge it with one rush into the tile, effecting thereby a long period of intermission during which the soil was exposed to aeration and consequently purification, avoiding the constant saturation that a steady trickle from the house
drain would produce at the beginning of the 3092
drain, and bringing its whole length into equal requisition with each periodic outflow.

In this form the apparatus was somewhat extensively used in England and elsewhere. At my own house in Newport, where about 200 feet of absorption tiles performed their office satisfactorily for eleven years, I interposed a settling basin of about 100 gallons capacity in the course
of the drain leading from the flush tank to the 3093
absorption area. This held back coarser matters and a large proportion of the grease. There was, however, always some difficulty resulting from the adhesion of grease to the outlet of the flush tank requiring frequent cleansing of the siphon, and later such a disturbance of the accumulated matters in the settling basin has caused flocculent and greasy particles to float forward and in 3094
time to choke the drains. It became necessary from time to time (three times in the eleven years) to lift the whole series of tiles, and wash them and replace them.

The next improvement was to place the settling basin between the flush tank and the house serving as a grease trap protecting the siphon of the flush tank against the gradual accretion of grease,

and leaving only a relatively clear liquid to be discharged into the pipe. This was a great improvement and practically effected all that was necessary where only the small flow of the kitchen sink was to be taken care of. It was found, however, when it became a question of disposing of the entire waste of the house includ-
3096 ing water closets, baths, etc., that the flow into the settling basin had at times sufficient force so to disturb its deposits as to cause a considerable amount of semi-solid matter to pass over into the flush tank, leading in time to the obstruction of the drains. This has been remedied by constructing in the settling basin a division wall at right angles to the line of flow, and built to about the height of the ordinary water level. This wall dividing the basin into two chambers confines the
3097 disturbance caused by the inflow to the first chamber. The flow from this into the other chamber being in a thin stream over the top of the wall does not disturb the deposits and only the liquid passes into the flush tank.

. . . .

These developments of the system, simple though they are, have been slowly worked out to meet a succession of difficulties which have arisen
3098 in practice. They have now had sufficiently long application and sufficiently extensive trial to make it prudent to assert the practical efficiency of this method of disposal.

It is in fact a perfect system for the disposal of liquid household wastes, practically and theoretically with a single limitation, namely, it still involves the retention of a cesspool of inconsid-
3099 erable size. It is impractical to allow the discharge of kitchen and water closet matter, including paper, to flow directly into the flush tank. It would soon obstruct the siphon and so much of it as is passed on into the drains would soon obstruct these. It is imperative that such matters should be withheld until by maceration or by decompisition they will pass on in solution or in suspension in a liquid flow. In so far as de-

composition is necessary the settling basin is in a less degree subject to the theoretical objections that are made to the cesspool. It is, however, to be considered that this settling basin which is perfectly tight as to its walls is so small that the volume of water passing through it takes up the products of decomposition and carries them on to the drains before they assume a condition at all 3101
comparable to that of the permanent cesspool. It is found practicable that the arrangement is inoffensive and safe. . . . . It has been a matter of surprise to all that have had experience with this system that the most severe frost seems to have no effect upon its working. In my own ground, where the absorption drains were five feet apart, the ground between them has been frozen to a depth of three and one-half
feet, yet the warmth of the sewage was always 3102
sufficient to secure its entrance into the soil.

It may be worth while to say a further word concerning the atmosphere of the settling chamber, which is in a certain sense a permanent cesspool. This air cannot fail to be made foul by the decomposition of the sewage there retained, but the frequent renewal of the small volume of sewage reduces this difficulty to the minimum. It is
desirable to remove the deposits of the settling 3103
chamber from time to time, as observation may show to be necessary. No rule can be fixed as to this. In some cases the decomposition is so complete that the chamber never accumulates much deposit. In others it should be cleaned out monthly. The proper relation between size of chamber, amount of water discharged and proportion of foreign matter in the water cannot be 3104
fixed in the present state of experience with the apparatus."

On page 291 is shown the settling chamber, flush tank, siphon outlet and absorption field, which will be described more fully in another place.

On page 292 is the following statement as to the places where the sub-surface irrigation system has been put to use:

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"I introduced this system for the disposal of
the entire sewage of the village of Lennox, Mas-
sachusetts, about 1876. It worked well from the
start, save for one or two cases of gross neglect,
and has continued in use up to the present time.
During the past three or four years it has been
greatly overtaxed. What was intended for a pop-
ulation of 1200 has been made to serve the needs
3106 of two or three times that population with a
greatly increased water supply. Works have re-
cently been constructed to carry a large part of
the sewage of the village in another direction for
disposal by sub-surface irrigation, but the old
field will be retained permanently to serve the
western slope of the village. I constructed the
same system for the disposal of sewage at the
Woman's Prison, at Sherbourn, Massachusetts, in
3107 1879. The area available was small and the soil
was not especially suitable. But in spite of this
the disposal and purification have been effected
and satisfactory, at least up to 1887, since which
I have had no information concerning it. The
same system constructed for the disposal of the
sewage of the hotel at Bryn Mar, Pennsylvania,
was entirely successful from the date of its con-
struction in 1881. until the hotel was burned
3108 five or six years later. I should not hesitate to
adopt this system wherever needed for an insti-
tution or even a village of considerable size."

A better description and explanation of the pro-
cess of sub-surface sewage disposal was made by
Colonel Waring in a paper on House Drainage,
published in Pepper's System of Practical Medi-
3109 cine, Lea Brothers & Company, Philadelphia,
Pennsylvania, in 1884, and re-published in Sewer-
age and Land Drainage, pages 294 to 303. The
following quotations are from pages 302 and 303:

"The process in its best development, as ap-
plied to the drainage of single houses, may be
thus described, many of the appliances used being
the subject of patents. The outflow from the

house is delivered into a settling basin or grease trap of sufficient size to still the flow to cause solids to settle to the bottom and grease and other light matters to float at the top. The outlet from this basin is through a pipe having its inlet at some distance below its overflow point, that is, at the level of the comparatively clarified liquid below the grease and above the sediment. The 3111
outflow passes into another vessel known as the flush tank where it accumulates until it reaches the summit of a self-acting siphon. This height being reached any considerable additions to the flow sets the siphon in action, and the whole contents of the flush tank are discharged with rapidity into the drain beyond. The discharge completed, air is automatically admitted to the siphon and no farther flow can take place until the flush
tank has again been filled. The drain of iron or 3112
vitrified pipe tightly jointed is continued to the edge of the ground upward for purification. It here delivers into a series of open-jointed agricultural tiles laid with their bottoms not more than ten inches below the surface of the ground. The total length of these tile drains is regulated according to the discharge of the siphon of the flush tank with a view to their becoming entirely
filled at each discharge. Within a short time 3113
after the flow has ceased the liquid has left all the pipes and entered the soil, its impurities being retained and its filtered water settling away into the porous or artificially drained ground below. During the interval between the discharges of the flush tank, a day or more, the process of purification (oxidation) of the retained impurities goes on in the soil, and its thorough aeration
prepares it to purify the exit discharge. This 3114
method of disposal is now employed in connection with hundreds of houses and its use, which has in some cases continued for a dozen years is constantly increasing. . . . .

For an intermittent discharge some form of flush tank is an absolute necessity. It is often found in practice where the flow of sewage from

3115 the house is considerable that the discharge of the house drain into the settling basin produces such an agitation of its contents as to set in motion and carry into the flush tank bits of paper partly macerated, grease, etc. This has been met by recent improvement which consists in building a transverse wall in the settling basin which
3116 checks the current from the house drain and causes the flow from the house side of the wall to pass over its top in a thin, small current which does not materially agitate the contents of that part of the basin from which the overflow pipe is fed.''

The process of sub-surface irrigation finally developed by the successive labors of the Rev. Henry
3117 Moule, Rogers Field and Colonel Waring, who patented the settling basin between the flush tank and the house was finally taken up about 1887 by Flush-Tank Company of Chicago that was organized by Colonel Waring, myself and others, and of which I was president, as one branch of the business in which the company was engaged. This published two catalogues each of which showed and describ-
3118 ed the structures and apparatus used for the purpose. I have no copy of the first catalogue. The second and the last one, however, was published by the company January 1st, 1892. The design of the intercepting chamber, flush-tank, and siphon shown on page 24 of the catalogue was made by myself and the description accompanying it was written,
3119 or at least revised by me. The action which was believed to take place in the intercepting chamber which is the analogue of the "septic tank" was thus described, pages 24 and 25 of the catalogue:

''The sewage is allowed to flow into the intercepting chamber where the solid matter is held until by decomposition it is so thoroughly mac-

erated that it will pass off in solution or into the
form of small particles in suspension with the
liquid. It has been found that unless the par-
tition wall in the intercepting chamber is used the
disturbing effect of the inflow from the sewer is
sufficient to cause considerable solid matter to
reach the flush tank, and hence the drains. This
wall confines the disturbance to the first part of 3121
the chamber. The flow over the wall, being a
thin stream, does not seriously disturb the de-
posits and only what is mainly liquid passes into
the flush-tank. For the flush-tank a modifica-
tion of the Rhoads-Williams siphon is used which
will not need explanation here, as it is more fully
described under the appropriate heads in previ-
ous pages. The system of intermittent sub-sur-
face irrigation as here described has been suc- 3122
cessfully applied, not only to numerous country
houses, but hotels, prisons, and even villages are
using it with satisfaction. It is practically and
theoretically a perfect system for disposing of
household wastes except that it involves the re-
tention of a cesspool of limited size which the in-
tercepting chamber amounts to in effect. By
ventilation the air of this chamber is far less foul
than that of the ordinary cesspool, and as it is
water tight the unpurified sewage is not allowed 3123
to find its way into the sub-soil. Deposits should
occasiosally be removed from this chamber,
though in some cases the decomposition is so com-
plete that it does not accumulate much deposit.''

During the time that the business of the Flush-
Tank Company was conducted under my manage-
ment from about the year 1887 to 1894 or '5, the 3124
company manufactured the siphons for and fur-
nished plans for building a great number of flush
tanks with the intercepting chambers for systems
for sub-surface irrigation. I did not attend to the
direct superintendence of much of this work, and
cannot now state from memory a great many places
in which they were built. I call to mind, however,

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one at Blain Lodge, on the north shore of Lake Michigan another one which I gave personal attention to, and the only one I gave personal attention to was built at Clarendon Hills, or West Hinsdale, Illinois, for George M. Bogue. These siphons for sub-
3126 surface irrigation and the plans as shown in the catalogue were shipped and sold all over the country.

The complete apparatus in all its parts for septic sewage purification as set forth in the Cameron patent, consists in their order, of a sewer or drain discharging into a settling tank which is con-
3127 nected with what is known as the septic tank in which the heavier solids go to the bottom and the lighter float to the top. From this tank the sewage is drawn off through an outlet disposed above the bottom of the tank and below the surface of the sewage, which said outlet consists of a slotted opening extending the greater part of the way
3128 across the tank. This outlet leads into a basin in which are placed aerating weirs or overflow dams designed to prepare the sewage for its final reduction by the aid of aerobic bacteria. The anaerobic bacteria having done their work in the septic tank. The apparatus developed by Colonel Waring and others as finally shown and described on page 291
3129 of Sewerage and Land Drainage, and page 24 of Flush-Tank Company's catalogue consists of a sewer or drain discharging into a basin which is divided into two parts and is termed the intercepting chamber, the first part being analogous to the settling tank of the Cameron patent, and the two parts together being the complete analogue of the

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combined settling tank and septic tank of the Cam-
eron patent. The outlet from the intercepting
chamber or septic tank, as it might well be called,
is disposed above the bottom of the chamber and
below the surface of the sewage, the only difference
between the two apparatus thus far being, that the
outlet of the Cameron septic tank is made with a 3131
long slotted opening, while the other one is made
as shown in the plain with a round pipe elbow turn-
ed down into the liquid. These elements comprise
really all that are essential to the septic tank as a
sewage purifying apparatus. After the sewage
leaves the outlet, the question of aeration is a
mere matter of method in detail. The Cameron 3132
patent shows a succession of overflow weirs. The
sub-soil method of sewage disposal by means of
the flush-tank developed by Colonel Waring and
others, accomplishes a thorough aeration by the
flow of the sewage from the outlet of the inter-
cepting chamber (septic tank) into the flush-tank
which is accomplished by a direct fall ranging 3133
from the total depth of the flush tank to zero. This
is the first aeration. A second one is accomplished
when the automatic siphon begins to overflow. The
air is for a time drawn in with the liquid and
passes off with it. The third aeration is accom-
plished most completely in the sub-surface ab-
sorption drains the sewage flows through the drains 3134
which consists of a wide ramifying system. The
fourth aeration is accomplished as the sewage
passes out through the drains into the soil and as
it percolates through the soil itself.

Considering the process part of the Cameron
patent in comparison to the action that takes place

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in the Waring apparatus, it may be said that each liquifies the solid matter of the contained sewage by the exclusion of light, air and the minimization of agitation, and by the action of anaerobic bacteria which works advantageously under such conditions.

3136 Adjournment is here taken until to-morrow, Friday, September 1st, 1905, at ten o'clock.

Friday, Sept. 1, 1905; met pursuant to adjournment; present as before.

Q. 6. As I understand it, the Flush-Tank Company, of which you were president, was organized for the purpose of constructing and installing ap-
3137 paratus for sewage disposal and for flushing sewers, and especially, so far as sewage disposal was concerned, for the purpose of constructing and installing the Waring apparatus described in your answer to question 5. Is this correct? A. Flush-Tank Company was organized for the purposes which you have named.

3138 Q. 7. When was that company organized, where and how long was it in business, and in how many instances did it apply the Waring apparatus for sewage disposal? A. It was organized under the laws of the State of Illinois, during the year 1887, as I now remember. The business of the company was transacted in Chicago, and the company had
3139 a manufacturing establishment here for several years. The company continued in business under the original organization until 1894 or 5, when the stock of the company was bought by others who conducted the business for a few years, and it was finally sold to Walcott, Hurlbut & Company of Chicago, and has passed into the hands of Mr. Mil-

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ler who is now advertising certain parts of the apparatus originally manufactured by the company. As before stated, I cannot give the number of instances in which we applied the Waring apparatus. I only know that we sold a large number of the siphons used for the flush-tank in sub-soil
irrigation as shown on page 24 of the company's 3141
catalogue and with which the company furnished plans of the type shown. In most instances these were shipped to a distance from one coast of the country to another, and were set by the purchasers. In some instances near Chicago the superintendent of the company would give personal attention to
placing them. In one instance I gave personal at- 3142
tention, namely at the residence of George M. Bogue, at Clarendon Hills, or West Hinsdale, at which place I advised him with reference to sewering his premises and in reference to laying out the system of sub-surface irrigation in his meadow.

Q. 8. As ordinarily constructed and used, how
large was the Waring apparatus, and so far as you 3143
know, how many people did it serve in any given case? A. Whenever an order was received by the company for furnishing the apparatus in any particular instance information would be obtained as to the probable amount of sewage which would have to be dealt with, and the capacity of the flush-
tank and the intercepting chamber, and the length 3144
of sub-soil drains, would be determined with such information at hand. The capacity of the flush tanks was never made less than 500 gallons, and in some instances a thousand and more. The capacity of the intercepting chamber was generally slightly less than the flush-tank, but in ordinary cases it

had sufficient capacity to retain the sewage an average of from twelve to twenty-four hours. The number of people which it would serve was dependent upon the establishment for which it was supplied. The capacity of the flush tank was intended to be sufficient to store the liquid portions of the sewage
3146 for about two days. The catalogue of Flush-Tank Company makes the statement on page 25 that for a family using water with ordinary freedom a flush-tank capacity of 50 gallons for each person would suffice.

Q. 9. Please look at this patent No. 223,826, issued to George E. Waring, Jr., January 27, 1880,
3147 and state what you know in reference to the apparatus described and shown therein? A. The patent referred to was one obtained by Colonel Waring in the course of his work of installing systems of sub-surface irrigation. The first application made by Rogers Field and himself of a flush-tank in connection with sub-surface irrigation was by admitting
3148 the sewage direct to the flush-tank. It was found that this gave trouble, that grease, particularly, would adhere to the siphon and finally choke it up. To meet this difficulty Colonel Warring devised the apparatus shown in said patent No. 223,826, which consisted at that time of a tank, A, placed between the flush-tank and the source of sewage. This
3149 tank as originally designed and as shown in said patent consisted of one chamber only with an inlet for the sewage and an outlet, the outlet being so constructed that it withdrew the sewage at a point above the bottom of the tank and below the surface of the sewage. This outlet led to the flush-tank as before described. This was the first step made by

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Colonel Waring after the application of the flush-tank itself to sub-surface irrigation. On putting this apparatus into use it was found that there was still too much disturbance in the liquid contained in the grease trap, and that grease, before decomposition had taken place, would find its way to the outlet. To avoid this, Colonel Waring added a 3151
transverse wall to the grease trap, and the combined apparatus was finally developed into the type shown on page 24 of our Flush-Tank Company's catalogue and on page 291 of Sewerage and Land Drainage. After being put into this shape it was found that not only would it retain the grease until it was disintegrated and dissolved so that it 3152
would pass off through the flush-tank without difficulty, but it was also found that other carbonaceous matter, such as rags, and paper, would be decomposed in the basin—in other words, that the action of the true septic tank was established. These results were observed between the time that the said patent was issued in January, namely, 3153
January 27, 1880, and the time that Flush-Tank Company was organized prior to or about 1887.

Counsel for defendants offers in evidence letters patent of the United States, No. 223,826, issued to George E. Waring, Jr., January 27, 1880, for improvement in Flush Tank; and the same is marked 3154
Defendants Exhibit Waring Patent No. 223,826.

Q. 10. The catalogue of the Flush-Tank Company which you have been referring to is a duplicate of the one offered in evidence in connec-

tion with Mr. Snow's deposition as "Defendants'
Exhibit Catalogue of Flush-Tank Company, Chi-
cago." I now ask you to state when and where
such catalogue was issued, how many editions
were issued, how many numbers in each edition,
how extensive the same were circulated, and gen-
3156 erally any facts or circumstances within your
knowledge relating to their circulation or use
prior to 1897. A. There was but one edition
of the specific catalogue referred to issued, dated
January 1, 1892. Flush-Tank Company, how-
ever, issued its first catalogue in March, 1889.
The first catalogue contained the most of the sev-
3157 eral apparatuses shown in the second. It was
somewhat different in form, but contained all the
essentials of the apparatus which the company
was manufacturing and selling at that time. Each
of these catalogues were issued to the amount
of a few thousand and were circulated widely to
cities and engineers engaged in sanitary work
3158 and possible users of any of the apparatus made
by the company. The business of the company
extended from the extreme New England States
to California. Many of its siphons were sold in
the Pacific Coast States, and many as far east
at least as New Hampshire. The list of testimo-
nials given in the catalogue of 1892 following
3159 page 26 said catalogue will give some idea of
the widespread range of the company's business
that existed prior to 1891. A few of the cities
from which testimonials were obtained are as fol-
lows: Leavenworth, Kansas; Omaha, Nebraska;
Pueblo, Colorado; Escanaba, Michigan; Canton,
Ohio; Beatrice, Nebraska; Willimantic, Con-

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necticut; Kansas City, Missouri: Kearney, Nebraska; Massillon, Ohio; New Castle, Pennsylvania; Gadsden, Alabama; Youngstown, Ohio; Atchison, Kansas; Toronto, Canada; Pensacola, Florida; Fair Haven, Washington; Clinton, Missouri; Great Falls, Montana; Winston, North
Carolina; Butler, Pennsylvania; Jackson, Ten- 3161
nessee; Natches, Mississippi; Little Rock Arkansas; East Liverpool, Ohio; West New Brighton, Staten Island; Helena, Montana; Amsterdam, New York; Keene, New Hampshire; Dennison, Texas; Atlantic City, New Jersey. It also contains a testimonial from Charles Paine & Son,
New York, with reference to the use of sub-soil 3162
irrigation apparatus which they had installed in accordance with the company's plans.

I would also add that Flush-Tank Company had manufacturing arrangements with the firm of Gladding, McBean & Company, of San Francisco, California, who manufactured the com-
pany's apparatus and sold them throughout the 3163
Pacific Coast.

Q. 11. Please compare the construction and operation of the Waring apparatus described in your foregoing answer with the construction and operation of the septic tank described in patent No. 634,423, sued on in this cause, and state
wherein they are similar to or different from each 3164
other, limiting your comparison to claims 1 to 8, inclusive, 11 and 12, inclusive, and 20 to 22, inclusive of said patent. A. In the latter part of my answer to question No. 5 I made a comparison of the analogies and differences existing between the entire apparatus described by

Cameron in his patent and the entire sub-soil irrigation apparatus described by Colonel Waring in Sewerage and Land Drainage, page 291, and in Flush-Tank Company's catalogue, page 24. Taking the claims named by your question and set forth in the Cameron patent, I trace the an-
3166 alogies and differences between the process and apparatus described in said Cameron patent and the same for the Waring system of sub-soil sewage disposal, as follows, claim by claim:

Claim 1 of the Cameron patent is a process claim, which consists in subjecting the sewage under exclusion of air, of light and of agitation,
3167 to the action of anaerobic bacteria, until the whole mass of solid organic matter contained therein becomes liquified, and then subjecting the liquid effluent to air and light. In the Waring process of sub-soil sewage disposal with the apparatus sold and installed by Flush-Tank Company, the sewage was subjected to the action of
3168 anaerobic bacteria in the intercepting chamber from which air, light and agitation were excluded, the liquid part of the sewage being retained for twelve to twenty-four or more hours, and the solid parts indefinitely until liquefied or macerated. The liquid, on passing into the flush-tank and through the siphon and drain to the soil,
3169 was thoroughly aerated, but not in the presence of light. The only difference in the two processes as set forth by claim 1 of the Cameron patent was that the Cameron claim requires light as a part of the final process, while the sub-surface sewage disposal process was completed without light.

Claim 2 of the Cameron patent is also a process claim, which is merely a restatement of the process of claim 1 in different language, except that it includes the action of cultivating the micro-organisms which dissolve the sewage and says nothing with reference to the final purification of sewage after it has left the septic tank. 3171
Claim 1, however, would necessarily embrace the cultivation of micro-organisms, otherwise the sewage would not be subjected to anaerobic bacteria. Comparing claim 2 with the Waring system of sub-soil sewage disposal I find no difference in the two processes, each process being cut short at the outlet of the septic tank or the inter- 3172
cepting chamber.

Claim 3 of the Cameron patent is also a process claim, and is identical with claim 2 except that after the sewage has been subjected to the dissolving and liquefying organisms in the septic tank it is subjected to an aerating operation after leaving the said tank. This process is 3173
identical with what takes place in the Waring sub-soil sewage disposal apparatus as sold and installed by Flush-Tank Company.

Claim 4 of the Cameron patent, another process claim, is identical with claim 3, except that the septic sewage, after being aerated, is subjected to a filtering operation. In the Waring 3174
sub-soil sewage disposal process the septic sewage is also subjected to a filtering operation as it passes into and through the soil from the distributing drains. I, hence, find that the process set forth in claim 4 is identical with the process followed by the Waring sub-soil sewage disposal method.

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Claim 5 of the Cameron patent covers an apparatus for the purification of sewage which consists of the combination of a septic tank having an outlet disposed above the bottom and below the normal water level of the tank and open across the greater part of the width thereof, and
3176 an aerator connected with said outlet. The Waring apparatus for sub-soil sewage disposal also consists of a septic tank called an intercepting chamber with an outlet disposed above the bottom and below the normal water level of the tank, but it is not open across the greater part of the width thereof, the opening being a cylindri-
3177 cal one through an elbow turned down into the tank. It also has adjuncts which serve as aerators consisting of the flush-tank in which the septic sewage falls from the outlet to the level of the water or sewage in the flush-tank, and of an automatic siphon by means of which a second aeration takes place as the sewage flows through
3178 the siphon, then of a system of open jointed distributing drains through which the sewage flows in varying quantities and velocities and in which a third aeration takes place, a fourth aeration occurring as the sewage passes through the open joints of the distributing pipes into and through the soil. I, therefore, find that in all essential
3179 particulars the Waring sub-soil disposal apparatus consists in the combination of a septic tank having an outlet disposed above the bottom and below the normal water level of the tank, and three mechanical adjuncts each of which serves as an aerator, and is, hence, in all essential particulars identical with the apparatus described in claim 5 of the Cameron patent.

Claim 6 of the Cameron patent covers an ap-
paratus for purifying sewage, which combines
a drain or sewer, a settling tank connected there-
with, and adapted to receive the contents thereof,
a septic tank connected with said settling tank,
and provided with an outlet disposed above the
bottom and below the normal water level of the 3181
tank and open across the greater part of the
width thereof. The Waring apparatus for sub-
soil sewage disposal consists of a combination
of a drain or sewer, a receiving chamber formed
by a partition built transversely across the in-
tercepting chamber, and which acts as a settling
tank for the solid matter which is so heavy as to 3182
be deposited, and which is adapted to receive
the contents of the sewer, and a so-called inter-
cepting chamber which performs the functions
of a septic tank, the second chamber of which is
connected with the first chamber and is provided
with an outlet disposed above the bottom and
below the normal water level of the tank, but it 3183
is not open across the greater part of the width
thereof. I, therefore, find that the apparatus de-
scribed in claim 6 of the Cameron patent is iden-
tical with the Waring sub-soil sewage disposal
apparatus, part for part performing the same
function except as to the character of the out-
let. 3184

Claim 7 of the Cameron patent covers the com-
bination of a septic tank and an outlet therefor
disposed above the bottom and below the normal
water level thereof, said outlet comprising a
conduit having a longitudinal slot open across
the greater part of the width of the tank. The

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Waring sub-soil sewage disposal apparatus consists in the combination of an intercepting chamber (septic tank) and an outlet therefor disposed above the bottom and below the normal water level thereof, but it does not comprise a conduit having a longitudinal slot open across
3186 the greater part of the width of the tank. I therefore find that the apparatus described in claim 7 of the Cameron patent and the Waring sub-soil sewage disposal apparatus are identical, except as to the character of the outlet.

Claim 8 of the Cameron patent is identical with claim 7 except in the language used describ-
3187 ing the apparatus, and the analogies and differences between the apparatuses described by claim 8 and that of the Waring sub-soil sewage disposal apparatus are the same as given under claim 7.

Claim 11 of the Cameron patent covers the combination of a septic tank, an inlet disposed above
3188 the bottom of the tank and below the normal water level thereof and occupying the greater part of the width of said tank, and an outlet extending across the greater part of the width of said tank and disposed above the bottom of the tank and below the normal water level thereof; and is identical with claim 7 except that it provides
3189 for an inlet of the sewage below the surface and above the bottom. The Waring sub-soil irrigation apparatus consists of the combination of a septic tank called an intercepting chamber an inlet disposed above the bottom of the tank and below the normal water level thereof and an outlet disposed above the bottom of the tank and below the normal

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water level thereof; but neither the inlet nor the outlet occupy the greater part of the width of said tank. I, therefore, find that claim 11 of the Cameron patent describes an apparatus which is identical with the Waring sub-soil sewage disposal apparatus except as to the character of the inlet and the 3191
outlet.

Claim 12 of the Cameron patent describes an apparatus that differs only in an unimportant detail of the outlet from that described by claim 11. Hence all remarks and conclusions made and drawn under claim 11 apply to claim 12.

Claim 20 of the Cameron patent describes an 3192
apparatus consisting of a combination of a septic tank, means for excluding air and light, a non-disturbing inlet for said tank disposed below the normal water level thereof and provided with a broadened mouth, a non-disturbing outlet for said tank disposed below the normal water level thereof and provided with a broadened 3193
mouth, and a sewage conduit connected with said inlet. The Waring sub-soil sewage disposal apparatus also consists of a septic tank called an intercepting chamber, combined with means for excluding air and light, a non-disturbing inlet for said tank disposed below the normal water level thereof, but not provided with a broadened 3194
mouth, also with a non-disturbing outlet for said tank disposed below the normal water level thereof, but not provided with a broadened mouth, and a sewage conduit connected with said inlet. I, therefore, find that the apparatus described by claim 20 is identical with the Waring sub-soil sewage

disposal apparatus except as relates to the shape of the inlet and outlet.

Claim 21 of the Cameron patent is a process claim, which consists of liquefying the solid matter contained in sewage by secluding a pool of sewage having a non-disturbing inflow and out-
3196 flow from light, air and agitation until a thick scum is formed on the surface thereof, and a mass of micro-organisms have been developed of a character and quantity sufficient to liquify the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms and then subjecting said pool under the cover of said scum
3197 and under a non-disturbing inflow and outflow to the liquefying action of the so cultivated micro-organisms until the solid matter contained in the flowing sewage is dissolved. The process thus described is covered fully by the process claims 1 to 4, inclusive, the only difference being in the language used in describing the process, and all
3198 the analogies and differences between the process thus described and the process which occurs with the Waring sub-soil sewage disposal apparatus as noted under claims 1 to 4, inclusive, exist in this case. I, therefore, find that claim 21 of the Cameron patent describes a process of sewage liquefaction and disintegration identical with
3199 that which takes place in the Waring sub-soil sewage disposal process.

Claim 22 of the Cameron patent covers an apparatus consisting of the combination of a septic tank, means for excluding air and light, a non-disturbing inlet for said tank disposed below the normal water level thereof, a non-disturb-

ing outlet for said tank disposed below the normal water level thereof, and a sewage conduit connected with said inlet. The Waring sub-soil sewage disposal apparatus also consists of the combination of a septic tank, called an intercepting chamber, means for excluding light and air, a non-disturbing inlet for said tank disposed be- 3201
low the normal water level thereof, a non-disturbing outlet for the said tank disposed below the normal water level thereof, and a sewage conduit connected with said inlet. I, therefore, find that the apparatus described in claim 22 of the Cameron patent is identical with the Waring sub-soil sewage disposal apparatus. 3202

A comprehensive comparison between the process of sewage purification described in the Cameron patent claims 1 to 4, inclusive, and claim 21, and the process followed by the Waring subsoil sewage disposal method shows that there are no essential differences existing between them. Each provides for the retention of the sewage in 3203
a tank in substantially the same manner from which light and air are excluded and in which the liquefying and disintegrating process takes place with the aid and through the instrumentality of anaerobic bacteria as the main active micro-organisms. Whatever changes will occur in either case, or in the use of either process 3204
through other instrumentalities than the anaerobic bacteria would be equally effective in each of the described processes. It is true that in the Cameron process mention is made of a final purification taking place by means of aeration and in the light. As has been seen, both processes

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supply thorough aeration. The final conclusion of the process in the presence of light is no essential part of either process, the facts being that final purification occurs in any method of purification by reason of the activity of aerobic bacteria, which bacteria can operate and do operate
3206 independently of the question of light. But even as regards this it was apprehended that the occasion might arise in which it would be preferable to discharge the sewage onto the surface of the ground rather than through sub-soil drains, as will be seen on page 26 of Flush-Tank Company's catalogue, which says:

3207 "In cases where tilled land or a garden lies in a proper position household wastes can be disposed of with success by the use of the same or a similar apparatus as that described for sub-surface irrigation with the omission of the absorption tiles. If the main discharge pipe be carried to the surface, the sewage may be allowed to spread over the ground without offense or injury."

3208 In view of these considerations with reference to the final disposition and purification of the sewage, I find that even in the matter of the presence of light, there is no difference between the two systems. The reference in the Cameron claims to the final decomposition of the sewage being completed in the presence of light is only
3209 suggestive, at least is no more substantial than that contained in Flush-Tank Company's catalogue above quoted, with reference to its disposition over the surface of the ground. This view is farther substantiated by the fact that in the apparatus claims of the Cameron patent no method of final purification is suggested that involves

a mechanical invention, the only reference being to a filter as the final apparatus to be used, which may or may not be the ground surface upon which the sewage is discharged.

A comparison of the apparatus described by the Cameron claims, 5 to 8 inclusive, 11 to 12 inclusive, and in 20 to 22, inclusive, with the War- 3211
ing sub-soil sewage disposal apparatus, in their general and essential features, shows that there is no difference between the mechanical parts involved except in slight matters of detail the omission or retention of which cannot have any material modifying effect. These matters of detail in fact relate to the form of inlet and out- 3212
let; to the manner of combining the settling basin with the septic tank, and to the mechanical method of aerating the septic sewage as it leaves the septic tank. The long slotted inlet and outlet described in the Cameron claims each submerged below the surface of the sewage and each disposed above the bottom of the tank, which 3213
operate to minimize the disturbance in the flow of the liquid through the tank is fully met in the effect produced by the cylindrical and submerged inlet and outlet of the Waring apparatus combined with the transverse partition dividing the first part of the intercepting chamber or septic tank from the second. The sewage in passing 3214
from the inlet to the second part of the chamber would spread fanlike through the chamber and overflow in a thin sheet. It would thence converge in a reverse course to the outlet, the nondisturbing effect being fully equal to the effect and use of the apparatus described in this Cam-

eron patent. The third matter of detail in which there are varations relate wholly to the mechanical means for aerating the sewage. In the Cameron apparatus it is a succession of weirs placed one lower than another in the same basin or channel over which the sewage flows one by one.
3216 In the Waring sub-surface sewage disposal apparatus it is a succession of mechanical methods of dropping the sewage from one height to another and of its flow in an irregular way through the distribution drains into the soil. I hence find that there are no essential differences between the apparatus described by the Cameron patent
3217 and that used in Waring's sub-surface sewage disposal process, while the results accomplished by the two apparatuses are analogous throughout.

Q. 12. In addition to the language which you have already quoted, do you find anything in the Flush-Tank Company's catalogue relating to the
3218 effect of the Waring process upon the solids in sewage? If so, please refer to the same or make such quotations thereof as you consider necessary? A. There is one paragraph on page 26, Flush-Tank Company catalogue which had its proper place with the quotation given as a part of the historical record of the development of the sys-
3219 tem under consideration, as showing the purposes which were aimed at at the time that said catalogue was published and prior thereto. The paragraph is as follows:

"This company owns patents covering not only the various forms of flush-tanks used for intermittent sub-surface and surface irrigation as described, but it also owns the patent of Colonel

George E. Waring, Jr., covering the use of a grease trap or intercepting chamber between the flush tank and the house to hold back the solid matter until dissolved or macerated; and to use a dividing wall in the intercepting chamber allowing the liquid to flow in a thin sheet over its top for the purpose of more fully detaining the solid matter until sufficiently macerated.'' 3221

Adjourned until Tuesday, September 5, 1905, at ten o'clock A. M.

Wednesday, September 20, 1905, ten o'clock A. M.; met pursuant to adjournment; present as before.

For entries showing sessions since September 5, see depositions of John W. Alvord and others, *post*. 3222

Cross-examination of Mr. Williams by Mr. Fisher:

XQ. 13. In your answer to Q. 4, you stated that "As applied to towns or cities, the only actual 3223
method of sewage disposal which I had experience in prior to that time (1897), consisted in discharge into water courses or bodies of water and land disposal." Did any of these systems for towns or cities involve the use of sewage disposal tanks? A. Not a tank of the character to which you refer, as I take it. The system of sewerage at 3224
Pullman had a receiving tank for the sewage of the town from which the sewage was pumped to an irrigation field, passing through a screening chamber before being delivered to the land; and also a system of sewerage at Aberdeen, South Dakota, where the sewage was collected in a reser-

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voir or underground tank and pumped for a distance to a water course.

XQ. 14. In your answer to Q. 4, you also stated
"As applied to isolated houses, I have had ex-
perience with one phase of land disposal known
as sub-surface irrigation, and in connection there-
3226 with became familiar with and employed the
method developed by Colonel George E. Waring,
Jr., and others." Had you prior to 1898 had experience with any other system involving the use of a sewage disposal tank besides that mentioned in your answer to Q. 4. A. No, sir.

XQ. 15. Do you regard the system employed
3227 by Colonel Waring and the tank illustrated in
Flush-Tank Company's catalogue as the nearest approximation in the prior art to the invention set forth in the Cameron patent in suit? A. It was the nearest approach to the Cameron septic tank with which I was personally connected in a constructive way. I had knowledge of other appli-
3228 cations of tanks of a septic character that may or
may not have been a nearer approach than this.

XQ. 16. Who were the officers of the Flush-Tank Company at the time you were connected with it; and who were and are the successors to the Flush-Tank Company? A. The first board
of directors of Flush-Tank Company, which as I
3229 now remember were not changed while I had to do
with the company, were Colonel Waring, Mr. Theodore Sheldon, of Chicago, and myself. I was elected president of the company and held the office as long as the company was under the management of this board of directors. I do not now remember who was the first secretary of the com-

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pany. Whoever it was, it was nominal. Subse-
quently as the business of the company became
larger and the company manufactured its own ap-
paratus Mr. Charles Poore, was, I believe, made
secretary, and among other things, looked after
the filling of orders, and the manufacturing and
shipping of the goods. Mr. Pontes Carlson, of 3231
Western Springs, Illinois, was, I think, foreman
of the shop for at least a time. The firm of E.
Baggott & Company manufactured the siphons for
a while before the company fitted up a shop. The
firm had a shop in connection with its house drain-
age and plumbing works. The superintendent of
Mr. Baggott's shop is a man by the name of Ter- 3232
rell. I do not remember his initials. The stock
of Flush-Tank Company was finally sold to W. N.
Wilson, who conducted the business a while in
Chicago, and removed it to Richmond, Indiana,
and he subsequently sold to Walcot, Hurlbut &
Company of Chicago. The conditions of the sale
and character I know nothing about. 3233

XQ. 17. State the names of any person or per-
sons who superintended the installation of any
flush-tanks like that described in Flush-Tank Com-
pany catalogue? A. Mr. Charles Poore, whose
present address is, I think, Los Angles, California,
superintended some of the tanks put in in the vi-
cinity of Chicago. When an order was received for 3234
the apparatus and plans from a distance he would
ship the apparatus and send directions in regard to
constructing the tanks, and to the best of my knowl-
edge, never visited the place where the construc-
tion was going on. Many of these orders came
through the Drainage Construction Company, of

Newport, Rhode Island, which was a company organized by Colonel Waring and others for the construction of sewage plants; and when an order came through them it was generally connected with work they had in hand and presumably they looked after its installation.

3236 XQ. 18. Did you inspect or supervise any tanks of the Waring type or such as shown in the Flush-Tank Company catalogue other than that at the residence of Mr. Bogue, at West Hinsdale, Illinois? A. Not of the exact Waring type, where there were two basins involved. I am very familiar with tanks into which sewage is run and held and drawn off
3237 gradually, and where septic action takes place.

XQ. 19. Give the locations of all flush tank installations of the type set forth in Flush-Tank Company catalogue that you ever saw or of which you are aware? A. I cannot state the location of any except those already mentioned. The order book of Flush-Tank Company and all their records pass-
3238 ed out of my hands when the stock of the company was purchased and without such records I could not name the places where tanks had been furnished.

XQ. 20. Do you remember the relative dimensions of the basins or chambers of the tank at Mr. Bogue's residence? A. My impression is they were five feet in diameter and whether there was any dif-
3239 ference between the flush tank and the intercepting chamber I cannot tell; nor can I be sure of the dimensions of either. These dimensions were always fixed with a view to the probable amount of sewage produced at the houses where they were installed.

XQ. 21. Do you know where any flush tanks like that shown on page 24 of Flush-Tank Company's catalogue are in use at the present time? A. I do not. Since I ceased to have any connections with Flush-Tank Company, my work has been in other lines and I have not followed up that particular phase of it, except in the sewerage of towns and cities in some instances.

XQ. 22. In your answer to Q. 10. you have giv- 3241
en a list of testimonials that are found at the back of the Flush-Tank Company catalogue. Please state which of these testimonials refer to siphons merely, and which refer to flush-tanks, such as illustrated on page 24 of the catalogue? A. The last one signed by Charles Paine & Sons, refers to
a sub-soil irrigation system of which Flush-Tank 3242
Company furnished the siphon and plans. The next to the last one from Atlantic City, signed by Fred P. Currie, also refers to a plant of that nature, I think, for the reason that at that time we sold no Field-Waring siphon except in connection with sub-surface irrigation, or some method of sewage
disposal, and the places where these are used would 3243
indicate that they were isolated plants, one being the Pennsylvania Railroad Company, and the other the Chelsea Improvement Company. I think that the testimonials aside from those which I have just mentioned, refer to sewer flushing tanks and siphons, and it is possible that the one from Atlantic
City refers to the same. 3244

XQ. 23. Have you designed any sewage disposal systems involving the use of tanks since 1898, and if so, of what character? A. Yes, sir, I designed a sewage disposal system which involved several tanks for the City of Aberdeen, South Dakota, since 1898. It involved septic action; and it also involved the filtration and final purification of sewage through a mechanically aerated filter.

XQ. 24. Please describe what kind of sewage disposal system was in use at Aberdeen before you installed there the septic system mentioned in your last answer? A. The system mentioned in my last
3246 answer has not been installed. The question was whether I had designed it. Plans were submitted something over a year ago, but the city has not yet made its financial arrangements for carrying them out, or at least they had not at the time of my last information. The system now in use at Aberdeen is what is known as a separate system of sewerage
3247 discharging into an underground tank or well, from which the sewage is pumped by a hydraulic pump into a dry stream. This system was installed by me about in 1888. The sewage went into a stream that carried no natural flow for a large part of the year and the stream bed itself became a septic tank with a thick heavy scum over the top of
3248 the sewage and being not very far removed from the town, putrefaction set up and became offensive. It was and is the desire of the city to overcome the difficulty.

XQ. 25. Will you please describe somewhat more in detail the septic tank that you say you have designed for the City of Aberdeen? A. The
3249 first tank was cylindrical in horizontal section, possibly about thirty feet in diameter, although I cannot remember distinctly not having looked up the plans for some time. This tank consisted of two chambers, a central chamber, into which the sewage first enters and from which the sewage flows into the outer

chamber, the depth of sewage in these chambers being about fourteen feet. From this outer chamber of the flush tank, the sewage passes to two twin tanks of the same size as the first tank, each of which tanks are divided into three chambers which are filled with rubble stone through which by a system of ducts underneath sewage is passed suc- 3251
cessively from one to another and finally to an aerating filter.

XQ. 26. Are you the Benezette Williams to whom U. S. letters patent, No. 252,344, were issued January 17, 1882? A. Yes, sir.

> It is stipulated between counsel that an uncertified copy of Williams patent, No. 3252
> 252,344 may be used upon the hearing of this cause with the same force and effect as if it were formally introduced in evidence.

XQ. 27. Have you published any descriptions or statements in regard to sewage disposal systems in which tanks are employed? A. No, sir, except 3253
as found in Flush-Tank Company's catalogue.

XQ. 28. State in what way, if at all, you are directly or indirectly interested in the installation of any sewage disposal system involving the use of septic tanks and in what way you are recompensed for your services in this case? A. I have no interest in any company or any patent that has relation 3254
remotely or otherwise to any system of sewage disposal. My compensation in this case comes because I was employed to give the history and description of the Waring sub-surface disposal apparatus. I understood from Mr. Alvord, who made arrangement with me, that the Village of Saratoga

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Springs and some others, none of whom I now remember, except the Allis-Chalmers Company, were supplying the funds for the testimony in this case. My understanding is that I am to receive some compensation through Mr. Alvord.

BENEZETTE WILLIAMS.

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September 5, 1905; met pursuant to adjournment; present as before.

The further taking of Mr. Williams's testimony is suspended to enable the examination of Mr. Alvord, and perhaps other witnesses, whose depositions are to be inserted in the record immediately following Mr. Williams' completed testimony. 3261

John W. Alvord, a witness produced, sworn and examined on the part of defendants, deposes and testifies, as follows, in answer to questions by Mr. Banning:

Q. 1. Please state your name, age, residence and occupation? A. My name is John Watson Alvord; 3262
I am 44 years of age, and reside in the City of Chicago, and am by profession a hydraulic and sanitary engineer.

Q. 2. Please state what experience you have had as an engineer, particularly in sanitary work? A. I have been engaged in sanitary work for a little over twenty-five years, commencing with the con- 3263
struction of the Hyde Park and Lake View stations of the Chicago Water Works, also assisting in the design and construction of the sewer systems of Hyde Park and Lake View, now annexed to the City of Chicago. From 1884 to 1888 I was City Engineer of Lake View, now annexed to Chicago, and had charge of the operation of the Lake View Water 3264
Works, and the design and construction of the Lake View sewer system.

In 1888 I visited Europe and commenced my study of the subject of sewage purification by an examination of the sewage farms of Berlin and Paris, and a visit to some eighteen or nineteen

sewage purification plants in England. Since that time I have been a very close student of the subject of sewage purification by careful examination of sanitation literature. Only since 1898, however, have I been actively engaged in designing sewage purification plants, and the first plant which I con-
3266 structed was built in that year.

I have designed sewer systems, however, for some forty-five different municipalities, a large portion of which are constructed and in successful operation. Since 1898 in the work of sewage purification I have advised in the design of something like 30 sewage disposal plants of which twenty-five were
3267 for municipalities and others for large institutions. Of these designs about two-thirds have been constructed and are in operation. The largest problem I have been permitted to study was of the sewage disposal of the City of Columbus, Ohio, amounting to about 20,000,000 gallons of flow, my report on, which was published by the city in 1898.

3268 Among other larger plants constructed by me are those at Wauwautosa, Wisconsin; Lake Forest, Illinois; Holland, Michigan; Danville, Kentucky; Princeton, Illinois; Bluefield, West Virginia; Bedford, Indiana and DeKalb, Illinois.

Aside from the above described work, I have had some laboratory experience in chemistry and bac-
3269 teriology and have written a number of papers on the subject of sewage purification for scientific and technical societies.

Q. 3. Please state what societies you are connected with, particularly scientific societies? A. I am a member of the American Society of Civil Engineers, the Western Society of Civil Engineers, and the Illinois Society of Engineers and Surveyors. I am also a member of the American Public Health Association, the American Society of Municipal Improvements, the American Water Works Association, and the New England Water Works Association.

Q. 4. Please state whether you have been accustomed in your work to examine patents, particularly patents relating to the sanitary art, and whether your education and experience has been such as to enable you to readily read and understand patent specifications and drawings? A. I have had some experience with patents and their interpretation, and believe myself capable of reading and understanding them. 3271 3272

Q. 5. Have you examined, and do you understand the Cameron, Commin and Martin patent, No. 634,423, dated October 3, 1899, sued on in this cause, and do you understand the apparatus and process described and claimed therein? A. I have and do. 3273

Q. 6. Please explain the art of sewage disposal as it existed and was known prior to 1897, with particular reference to its bearing on the apparatus and process described in said patent No. 634,423, sued on in this cause? A. The art of sewage purification is a very old one in its practical application, and we find even in the time of Moses that 3274
it was commended that the offal and excrement be taken outside of the camp and burned.

As the art exists to-day, however, its real interest and history is coincident with the rise and discovery of the science of bacteriology with which it is now closely identified.

We find as far back as in the year 1825 that Cagnard de Lar Tour expressed the opinion that organized susbstances, that is to say, micro-organisms, played some role in fermentive and putrefactive changes. (The sewage question during the last century by Alfred Roeschling, Transactions of the
3276 Society of Civil Engineers, 1901, page 193). Later, about 1835, Schwam expressed substantially the same opinion as La Tour, but independently. This was theory only, and was successfully controverted for many years, commencing about 1845, when Justus Von Liebig, denied the theories of La Tour and Schwam, and advanced the Catalytic theory,
3277 which was in brief that putrefying substances had the abilities to communicate their chemical change by actual contact.

During all this time in England, cesspools, tanks and middens or privies were in common use, even for large cities; but about the year 1847 sewers began to be advocated to take their place, and it
3278 was made compulsory to abolish cesspools. From that time on began on a large scale the pollution of the rivers of England, and as a practical consequence it was found that the difficulty had only been transferred, and not remedied by the introduction of sewers. The general introduction of sewers was fully under way in England by the
3279 middle of the century, and by 1857 the Thames River below London had reached the condition which was considered a national disgrace.

Sewerage systems in the United States were generally introduced about the year 1850, that is to say, systems designed on scientific principles. About 1857 the pollution of rivers became so mark-

ed that Mr. Henry Austin was engaged to make a report to the general board of health upon the subject, he being the chief superintending inspector of the board. Mr. Austin's report recommended settling tanks with filtering materials at the outlet, and describes tanks at Clifton Union, Cheltenham and Ely. He also suggests a form of tank of his 3281
own, a copy of which has been introduced into the testimony in this case, by Mr. Snow, and marked "Defendants' Exhibit Proposed Sewage Works, Austin." Mr. Austin states, with reference to this proposed tank, on page 32:

"The great bulk of the matters in suspension is separated and retained. * * * The heavier 3282
matters of the sewage deposit themselves at the bottom of the tanks, but a large proportion of the solids forms itself into a floating body, and accumulates to about eighteen inches thick on the surface. The liquid is conveyed from the angular filters in the upper tanks by a line of pipes in each division."

Mr. Austin's plan shows non-disturbing outflow
from his tank, floating scum upon the surface of the 3283
liquid and a tank of considerable capacity in proportion of the flow within the sewer as shown by the flow line within the sewer in the drawing. Mr. Austin very accurately describes the physical action of the solids in suspension which would take place within such tanks, and which has been quoted
in the evidence in this case by Mr. Snow on type- 3284
written page 39 herein. Mr. Austin's report was the first organized attempt to adequately study the problem of sewage purification, and it is significant that his recommendations are along lines, so far as preliminary stages are concerned, that are considered today as desirable and rational. Fol-

lowing his report, attention began to be turned to tanks for promoting plain subsidence, and in January, 1860 British patent No. 232 was taken out by Thomas Walker, for an arrangement of tanks to promote plain subsidence by bringing the sewage to a state of rest in a broad pool. At Croyden, Eng-
3286 land, sewage works were built in 1861, which consisted of two small settling tanks in duplicate with baffle boards and baffle walls, and with a submerged non-disturbing inflow and an outflow through perforations in a masonry wall at middepth by which the sewage passed into a coarse strainer. (Sewage Disposal Works, by W. Santo Crimp, page 151,
3287 1890).

The significance of Mr. Henry Austin's work in recommending as a preliminary state plain subsidence is not only seen in the use of these early tanks at Croyden, but in a still more marked manner in the sewage works of Ealing, which were built about the year 1863, and were the first sewage works to
3288 be built in the valley of the Thames, Ealing being a Western suburb of London.

These works were notable for their extension of tanks as a first stage, and indeed carried separation tanks as a first stage, and indeed carried this idea much further than was done by Mr. Austin in that they provided for a much longer stay
3289 of the sewage within the subsidence tank than was probably indicated by his recommendation. The works are described in a book entitled "Sewage Disposal Works, by W. Santo Crimp, published by Charles Griffin & Company, Exeter Street, Strand, London, in 1890, the description being found on page 158 and following. I quote from page 163:

"Probably that which strikes the visitor to these works most is the very large area devoted to effluent water tanks, and there can be no doubt that to this specialty very much of the success of the work is due. Mr. Jones claims to have a larger amount of tank space at Ealing than at any town in England."

I quote from page 162. 3291

"In designing these works, Mr. Jones, after a careful investigation of the various best known sewerage works in the country, decided upon a system of subsiding tanks, supplemented by chemical precipitance (where and when necessary) believing that an effluent might be produced which would satisfy the requirements of the conservator of the River Thames into which the effluent is discharged, and the fact that for 3292
26 years these works have under the supervision of Mr. Jones met with the approval of not only the Thames conservator, but of a very large portion of the men best qualified to judge of their merits, is a very fair evidence of their efficiency and their work."

On page 159 I find it stated that the capacity of the deposit tank and the spaces under the filter bed 3293
which are employed as deposit chamber amounts to 17,500 cubic feet, which I have computed as equivalent to a little over 131,000 gallons, and on page 160 I find the daily volume of sewage flow given at 400,000 gallons. The period then that the sewage would be brought to a state of rest comparative within a continuously flowing tank of this 3294
character would be practically eight hours, a period which would afford ample opportunity for decomposition of the solids. It is significant that in writing a description of these works many years later, and at a time when the chemical purification of sewage had reached its greatest vogue that the

author of this book, Mr. Santo Crimp, should have found it necessary to go into considerable explanation as to the unsatisfactory character of these works. It is apparent from the information given that the filtered sewage was run into the Thames for many years by the board of conservators of
3296 the River Thames, and considered a satisfactory effluent, and even the analysis given by Mr. Santo Crimp himself in 1890 when a considerably larger sewage flow passing through the tank show a considerable and distinct reduction of solids in their passage through these tanks. The significance of which he does not appear to grasp.

3297 The ideas of Mr. Henry Austin are further seen in the design for sewage works built in 1864, for the Aldershot Camp Farm, a description of which may be found with plans in the report of the Royal Commission on Sewage Disposal, Volume 4, 1894. The plans show three sets of tanks provided with scum boards and worked on the continuous inflow and outflow principles, followed by aeration.

3298 In 1864 the ideas suggested by Mr. Henry Austin were still further exemplified by British patent No. 2329, granted to Thomas Walker and T. F. Walker, for Improvements in Apparatus where sewage matters are collected in reservoirs in order that the fluid portion may be separated from the solids. These
3299 reservoirs are shown by the plans to be provided with a submerged non-disturbing inflow and outflow, and baffle boards to retain the floating scum. The effluent flowed over a weir by means of which the liquid was aerated.

While there is no adequate perception in all of these ideas for separating or sedimentation tanks of the principle of bacterial reduction, it must be remembered that at this time bacteriology itself had not advanced sufficiently to enable students of the problem of sewage purification to adequately explain the character of the changes which they observed going on in such tanks.

Nevertheless it must be seen that the suggestions 3301
of Mr. Henry Austin and those who followed his ideas were evidently made because close study had shown that a favorable change of some kind occurred in the solids of the sewage, and that an effluent could be obtained by means of such tank provided with a non-disturbing inflow and outflow generally
at middepth by suitable arrangements of baffle 3302
boards to contain and hold the surface scum, and by aeration of the effluent which materially advanced the success of the treatment of the sewage.

We will now turn to the bacterial side of the question and we find that as early as 1850 Mitscherlich proved that cellulose was dissolved by fer-
mentation (Sewage, by Samuel Rideal, published 3303
New York by John Wiley & Sons, 1901, page 89). About 1860 Louis Pasteur established the fact that fermentation and putrefaction were due to living organisms. His methods of biological examination left much to be desired, however, and the subject did not excite general interest at the time. He
showed pretty conclusively at the same time that 3304
living organisms were the cause of some, and probably of all zymotic disease (Roechling, Transactions of Engineers, for 1901, page 193). In 1865 Dr. Alexander Mueller, City Chemist of Berlin, reported that bacteria did the purifying in irrigation (Landwirthschaftliche, Versach Stationen XVI 273). He said of sewage:

"The contents of sewage are chiefly of organic origin, and in consequence of this, an active process of decomposition takes place in sewage, through which the organic matters are gradually dissolved into mineral matters, or, in short, are mineralized, and thus become fit to serve as food for plants. To the superficial observer this
3306 process appears to be a chemical self-reduction; in reality, however, it is chiefly a process of digestion, in which the various—mostly microscopically small—animal and vegetable organisms utilize the organically fixed power for their life purposes."

The work of Dr. Mueller in his experiments and the patent which he latter took out will be referred to later, but it is important here to know that he
3307 was probably the first scientist to first experiment with and fully and accurately describe the liquefaction of the solid substances in the sewage by means of bacteria.

Dr. Angus, in England, is said in 1867 by Warrington, (British Association for the Advancement of Science, 1887, page 653) to have first observed
3308 the action of bacteria in sewage. He afterwards published many experiments on the subject in the reports of the local government board of 1882 and 1884.

In 1868 the Rev. Henry Moule, a clergyman in England, published an account of the sub-surface sewage system referred to by Waring and others
3309 (Waring Sewerage and Land Drainage, page 288). His system consists essentially in tile drains laid just beneath the surface of the ground through which the sewage was made to flow and percolate by slow degrees into the surrounding soil. Later Mr. Rogers Field installed a system at Sheffield, in England, supplementing the drain of Mr. Moule

with a flush tank arranged to hold back the flow until a full, effecting intermittency of flow.

In 1880 Colonel George E. Waring, of Newport, U. S. A., took out a patent for a grease trap located between the house drain and the flush tank adopted by Mr. Field, thus originating what was later well known as the sewage disposal system for household 3311
wastes to be hereafter referred to at greater length.

In 1868 experiments were made by Dr. Franklin in England on the filtration of sewage through various soils. This work was done for the Rivers Pollution Committee and his conclusions are found in page 60 of their report for that year. The experiments show that the process of filtering through 3312
sand, gravel, chalk, if properly carried out, to be a most efficient means of purifying sewage. He did not at that time perceive that the action was other than a chemical change, however.

In 1868 the Rivers Pollution Commission report recommended limits to the pollution of streams.

In 1868 also presumably following out the earlier 3313
ideas of Henry Austin, Galvin Chapman took out British patent No. 3203, for Improvement in Treating Sewage in order to obtain valuable products therefrom. The process consisted of collecting in a large reservoir the sewage in such a manner that it might be decomposed, the decomposition being hastened by always leaving in the tank a quantity 3314
of previously decomposed sewage, and by maintaining the sewage at a temperature of 70 to 80 degrees Fahrenheit. This seems to have been a clear perception of the liquefaction of the solids in sewage by means of physical environment.

The same year (1868) Thomas Smith and John

Van Norden Bazelgette took out British patent No. 3562, for Improvements in Deodorizing and Manufacturing Manure from Sewage. Their process provided that the sewage should be introduced into a settling tank through openings in the wall of the tank at different heights, giving practically a non-
3316 disturbing inflow and outflow.

In 1870 Mr. Fritz Hille took out U. S. patent No. 138,250, for a process of treating sewage by depositing tanks, and combinations of depositing tanks and filter. Suitable baffles were provided to retain the floating scum.

Also in the year 1870 George William Wigner, a
3317 chemist of London, took out British patent No. 364 for Improvements in the Mode of Apparatus for Treating and Purifying Sewage, consisting first of a pit or tank through which the sewage was caused to pass slowly on its way by means of a non-disturbing inflow and outflow, after which aeration is obtained by means of a suitable weir.

3318 In 1870 Beven G. Sloper obtained British patent No. 1706 for Improvements in Treating Sewage Favoring Fermentation. His idea seemed to be to mix fresh sewage with purified sewage containing an abundant quantity of sewage ferment, such as acts very rapidly on the urea contained in the sewage, and leaves it thus mixed until
3319 the urea has disappeared, an estimated time of about one hour. This result was obtained by a suitable arrangement of tanks and baffle boards accompanied by slow agitation of the bottom of the liquid and withdrawal from the top.

There seems to have been here clear perception of the value and desirability of decomposition as a preliminary stage in further purification.

In 1870 George William Wigner took out U. S. patent No. 108,664 for Improvement in Sewage Apparatus consisting in a combination of brick chambers with settling tanks having a submerged outlet and being divided into different compartments by a transverse partition wall, the sewage passing in and out of the tank by a con- 3321
tinuous flow.

In 1871 Janus Brow Pow took out British patent No. 2760 for Improved Arrangements for Filtering and Purifying Sewage, also for Collecting Solids. The process consisted of first conducting the sewage into tanks for the subsidence
of the solids, secondly, introducing in other tanks 3322
certain chemicals, and thirdly, means for filtering the effluent. It is stated that the deposit will be mainly found in the first tank which will not have to be emptied more than once a week.

In all of these patents about this time are seen in one form or another the earlier suggestions
of Henry Austin for subsidence, and the means 3323
for controlling the solids and preventing their escape by means of non-disturbing inflow and outflow, baffle boards for retaining the surface scum, and in some cases a combination with aeration.

In 1870 and 1871 following the experiments of Dr. Franklin, which I have before alluded to,
Mr. Bailey Denton, an English engineer, first in- 3324
troduced sewage purification by means of intermittent filtration in Merthyr Tyvdil, in Wales. This was the precursor of land methods of treatment, both in England and in this country, which, for sometime distracted attention from liquefaction and decomposition as a first stage in sewage purification.

Nevertheless, in a small, and perhaps at this time, it even might be said an insignificant way, knowledge of bacterial nature of decomposition was gaining ground, at first among scientists accustomed to the experiments of the laboratory, and from them to engineers who kept in close
3326 touch with a scientific research of the day. In 1872 the Berlin Sewage Commission reported that sewage was converted into nitrates by organisms present in the natural sewage and soil, and not simply by a molecular process. (Sewage by Samuel Rideal, page 176.)

In 1872 also the Massachusetts State Board of
3327 Health in a special report discussed the possibilities of disposing of the sewage of the city of Worcester, Massachusetts, by intermittent filtration, and in their report of the same year they state that there are in England fifty-nine sewage farms, twenty-six chemical works, sixteen filtration fields, ten plain subsidence tanks, and
3328 three intermittent filtration systems. It will be seen from this census of the state of sewage purification in England that the subsidence tank suggested by Henry Austin and exemplified at the works at Ealing was still in high favor, and had not yet been so superseded by the chemical idea as later unfortunately became to be the case.

3329 I have heretofore spoken of the sub-soil intermittent filtration of the Rev. Henry Moule, its development by the sewage flush tank, and the addition by Colonel George Waring, of Providence, of the grease trap, so-called, between the house drain and the flush tank.

In 1876 Colonel Waring introduced what was

perhaps the first sewage purification plant for a
considerable town at Lennox, Massachusetts.
This system was mainly a sub-soil intermittent
filtration system, but there was a tank in con-
nection with it which was designed to retain the
sewage for a considerable length of time so that
the solids would not be passed over and clog the 3331
drain. This plant was intended for a popula-
tion of twelve hundred people, and an account
of this system was published in Colonel War-
ing's book in 1876. (See also Sewage Purifica-
tion in United States by Rafter & Baker, page
560.) (Also The Sanitary Drainage of Houses
and Towns, by George E. Waring, 1876.) In 3332
this book of Colonel Waring's he notes that mat-
ters in grease traps, such as he introduced and
patented, decomposes, and he describes an air-
tight tank with submerged inlet and outlet,
which he constructed at his house, New-
port, Rhode Island, which was about four feet
in diameter, in which the solids are liquefied. 3333

It is evident to me, from a review of the writ-
ings of Colonel Waring, that his original idea of
a grease trap, so-called, which he patented in
1880, was entirely designed to prevent solids
from being passed over into the flush tank and
the sub-soil drains of the filtration system which
was the usual accompaniment. I doubt, if, at the 3334
time of taking out this patent, he distinctly per-
ceived that any process of reduction went on in
the solid substances, but it is very evident to a
close student of his writings that immediately
after the adoption of this appliance, and its prac-
tical application, he began to perceive that there

3335 was an action going on, which tended to reduce or liquify the solids and decompose them. This action he describes six years after taking out his patent in his book published in 1876, and in later publications, notably his book published in 1884, he describes this action as being a maceration.
3336 Mr. Benezette Williams, in his testimony in this case, has quoted extensively from Colonel Waring's later writings, to show that he fully appreciated this reduction of solid organic matter by maceration and decomposition, and he even goes so far as to state that under proper conditions such grease traps, so-called, may not
3337 have to be cleaned.

To my mind it is peculiarly significant that Colonel Waring, whose views are everywhere urgently emphasized to the effect that sewage should not be allowed to decompose upon the premises or adjacent thereto, should have been thus compelled to discover under his own observa-
3338 tion, and by means of his own patent appliances, that sewage may be properly decomposed in tanks comparatively air and light proof without offense, and with great assistance to the subsequent aeration and filtration that was necessary to complete the process.

One of the first and most successful liquefying
3339 tanks in the United States was installed in 1876 at the insane asylum at Worcester, Massachusetts, by Messrs. Butrick & Wheeler, civil engineers. This plant is described in a book entitled "Sewage Disposal in the United States," by Rafter & Baker, published by D. Van Ostrand & Company, New York, 1894. The description

on page 456 giving plan and elevation of the plant and stating that it is the first successful irrigation works in this country which have continued to successfully dispose of the sewage. The plant consists of a large covered tank with a baffle wall across the center, a submerged non-disturbing
inlet and outlet, means for examination and 3341
cleaning, and of the capacity of about 30,000 gallons. The sewage is conducted from this tank to from thirty to forty acres of irrigation fields, where it is aerated and filtered, with a normal flow from 600 people this tank would give the sewage a rest period of from ten to sixteen
hours, during which time decomposition and 3342
liquefaction would have ample time to reduce the solid matters. No mention is made in the description of the frequency with which the sludge is cleaned from the settling tank.

In 1876 a sewage purification plant was built at Wimbleton, England, which is described in a
book entitled "Sewage Disposal Works," by W. 3343
Santo Crimp, published in London, in 1890, page 214. The plant consisted first of two sets of tanks for the reception of the sewage, having a total capacity of about one day's flow of sewage. These tanks are provided with coke strainers at mid-depth, and the sewage enters from the
bottom of one end of the tank, as shown by the 3344
diagram opposite page 215, and outward over the end of each tank. The diagram shows that solids were expected to be deposited upon the bottom of the tank. The description of this plant by Mr. Santo Crimp calls these tanks straining tanks, and Mr. Santo Crimp does not appear him-

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self to have had any perception of the liquefying action which we now know have inevitably taken place under such conditions.

It is evident to me, however, that the original designer of these tanks must have been largely influenced by the suggestions contained in the
3346 reports of Henry Austin, hereinbefore quoted, and the work of other designers along the same line in taking advantage of tanks intended to reduce the solids into such state that the resultant effluent might be more readily treated. That these designers were not aware that this was accomplished by bacterial action must be conceded,
3347 but the persistent design and application of these tanks seems to conclusively show that, so far as physical appearances could determine, favorable results were obtained in the resulting effluent which made them desirable. We shall see as we progress in the history of the knowledge of this art that from this time on the advantages of
3348 such tanks began to be lost sight of in the growing tide of the interest in processes which endeavored to clarify the sewage by the introduction of chemicals such as lime and alum; but it must not be lost sight of that during all this time a small minority were working toward the solution of the sewage purification problem by
3349 means of the reduction of the solids in tanks called at various times separating or subsiding tanks, and in which distinct advantages in the reduction of the solids had been physically observable from the time of Henry Austin on.

From 1877 on the growth and development of the science of bacteriology began to be rapid. In

the year 1877 Messrs. Schloessing and Muntz, two French chemists, published experiments which had been conducted at the Paris sewage farm proving that nitrification in the soil is due to the action of a living ferment, and of their work Mr. Robert Warrington says (Journal Society of Arts, Volume 30, page 533) "This is 3351
the first instance in which the action of living ferments has been shown to extend to inorganic bodies." These French scientists found that nitrification proceeded ten times more rapidly at 37 degrees centigrade than at 14 degrees centigrade.

In 1877 Professor Tanner, in the minutes of the 3352
proceedings of an institute of civil engineers, volume 49, page 180,182, describes sedimentation tanks with non-disturbing inflow and outflow, baffles for retaining the surface scum, and a capacity for dealing with a quantity which would give it all the essentials of a tank capable of liquefying the solids. 3353

In 1878 Colonel George E. Waring issued a new edition of his book, entitled "Sanitary Drainage of Houses and Towns," published by Hurd & Houghton, Cambridge, Mass., The Riverside Press, 1878. On pages 195 to 202 are essentially the same information published in the original edition of 1876. 3354

In 1878 Dr. Alexander Mueller took out German patent 9,782, for a process of disinfecting purification and utilization of putrescent waste liquid or liquid sewage by the rational publication of fermenting organisms. This patent has been quoted in this case by Mr. Snow on type-

written page 49. I will not repeat here the sub-
stance matter except that I should say that it
would be difficult at the present time from known
and true facts to make a much more exact and
scientific statement of the process of bacterial
liquefaction of solids, than is given by Dr. Muel-
3356 ler in his patent.

In England, in 1878, C. T. Kingzett described bacterial oxidation by micro-organisms (Annual Journal of Chemistry, page 44).

In 1879 at Sherborn, Massachusetts, in the
Woman's Prison, Colonel E. Waring installed a
subsidence tank and intermittent filtration,
3357 which he describes in his book, "Sewage and
Land Drainage," page 292.

In 1880 Colonel Waring took out U. S. Patent
223,826 for a combination of a grease trap and
a flush tank in the course of a drain or sewer.
This is the patent which I have before alluded to
as being an important step in the progress of Col.
3358 Waring's discovery of what he terms maceration
of the solid matter in sewage.

In 1881 Hatton investigated the conditions un-
der which oxygen was absorbed by sewage
(Chemical Society Journal, May, 1881, Action of
Bacteria on Gases and Reduction of Nitrates by
Sewage). In 1881 also Dr. Alexander Mueller
3359 published an account of his experiments, volume
6, page 263, of Landwirthschaftliche. A transla-
tion is also found in the journal of the society of
arts, volume XLVI., November 19, 1897, page
165, George Bell & Son, Convent Garden, pub-
lishers.

In 1881 Dr. Franklin published a paper in the

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Journal Royal of the Royal Agricultural Society, pages 241-311, entitled "On the Amount and Composition of the Rain and Drainage Waters Collected at Rothamsted. This paper was an account of the experiments which were commenced in 1870 and which were regularly conducted since 1877, showing that nitrification 3361
in the soil was due in origin to living ferments.

In 1881, at Amherst, Massachusetts, a small purification system was installed which is described in a book entitled "Sewage Disposal in the United States," by Rafter & Baker, page 61. The sewage of this plant was first received into a settling tank which was later built in two com- 3362
partments, and the effluent from which was flowed upon land.

In 1881 Colonel George E. Waring installed a tank for the maceration of solids and a filtration system for a hotel at Bryn Mawr, Pennsylvania. This tank and filtration system is said by him to have worked for six years successfully 3363
until the hotel was burned.

In the Engineering Record of September 1st, 1881, appears a description by an unknown "Constant Reader," of a proposed air-tight cesspool, on top of which the illustration shows floating a thick scum, the liquid from which was to be removed by submerged pipe and filtered through 3364
charcoal or another open tank. This may have been derived from the patent of Louis Mouras, who, in the same year was granted French patent, No. 144,-904, for an Automatic Scavenger. This patent has been quoted in Mr. Snow's testimony, on typewritten page 50, and is one of the exhibits in this case.

3365 I will not repeat here further than to observe that it is a singularly correct description of liquefaction, or septic-action, so-called, as we know it to-day. A full description of the workings of this tank was described. In Cosmos Mondes, December 18, 1881, page 622, and in 1882, page 97, and in 1883, page
3366 110. Quotations from these articles will be found in Mr. Snow's testimony on typewritten pages 51, 52, 53, 54, 55, 56, 57, 58, and 59. A large number of the so-called automatic scavengers were installed in Paris, and the Encyclopaedia Brittanica, 9th edition, volume 18, page 280, states that night soil is collected in three different ways, from cesspolls of
3367 masonry work which ought to be water tight, from open buckets, and from filtering tinetts. This article further shows that the quantity of solids taken from the tinetts was very much less than from any other source, showing, undoubtedly that reduction of solids had taken place to a much greater degree in these tanks with which the automatic scavenger was classed.

3368 The use of Mouras' automatic scavengers continued in Paris for many years until the Paris sewers were thrown open for all forms of sewage. The scavenger of Mouras consisted essentially of an air-tight and light-tight tank with submerged non-disturbing inflow and outflow, in which the solids might liquefy by bacterial action.

3369 In 1882 Robert Koch published new methods of bacterial investigation which so greatly simplified the study of the subject that bacteriology may have been said to have taken its rise as a general science from this date (Roechling Transactions, Engineering Society, 1901, page 193).

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In 1882, the Engineering News of New York City, published an acount of the Mouras Automatic Scavenger, under date of April 15; which was probably the first description in America. The article was accompanied with cuts showing the arrangement of the tank.

In 1882, M. F. Mogno, editor of Cosmos Mondes wrote an article describing the Mouras Automatic Scavenger, and attributes the liquefying acton to anaerobic bacteria. 3371

In 1882 there was installed at the school for boys at Lawrenceville, New Jersey, a sewage purification plant consisting of a large tank holding twenty-four hours or more sewage flow, arranged 3372
with non-disturbing inlet and outlet, a number of compartments being practically air-tight and light-proof, followed by aeration and filtration system. This tank is in all respects built as it would be to-day if it were designed to use liquefying action of bacteria upon the solids in the sewage. This plant is fully described in a book entitled "Sewage Dis- 3373
posal in the United States," by Rafter & Baker, page 511. It is stated that sewage was emptied from the effluent well eight times a month in which case solids would have had an opportunity of four days' rest in the liquefying tank. The liquefying tanks were not cleaned until 1887 when 300 cubic feet of sludge were taken from the first section. 3374

In 1883 there was published in the Institution of Civil Engineers, London, page 359, volume 72, an account of the automatic scavenger by Abbe F. Mogno.

In 1883 there was installed in the reformatory at Concord, Massachusetts, by William Wheeler,

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civil engineer, a sewage disposal plant, consisting of a liquefaction tank, 12 feet square and five feet deep, covered with a masonry roof and with an outlet at mid-depth. This plant is described on page 468, of Baker & Rafter. The effluent from this tank was received into a second chamber for storage and
3376 finally filtered. The capacity of the liquefaction tank was such that one and one half hours rest for the sewage was required, the solids of course, remaining until they were dissolved. This plant, undoubtedly produced liquefaction as we now understand the same and must have been intentionally designed for that purpose, in my opinion.

3377 In 1883 there was published in the Sanitary Engineer of May 10, and 17, an article by Edward S. Phillbrick, a professor in the Massachusetts School of Technology, describing a system of sewage purification by means of liquefying or macerating tanks, with non-disturbing in-flow and out-flow, baffle wall, and practically light and air tight. This
3378 tank was to be followed by aeration through a flushing tank and filtration. This article with its accompanying diagrams is on file as one of the exhibits in this case, and gives a clear and scientific account of the reduction of the solids of sewage by means of such tank and the increased possibility of their aeration and filtration. In the Sanitary Rec-
3379 ord, Volume 8, page 444, Mr. Phillbrick, in reply to an open letter, suggests for a hospital of 25 beds a mascerating tank, 5 feet in diameter and 5 feet deep, which would give eight to ten hours rest for the flowing sewage.

In 1883 a Mouras automatic scavenger was installed at the works of Mr. Herzog, at Logelbach.

This tank was air and light tight, with non-disturbing in-flow and out-flow, as was customary in the Mouras tanks. It had a capacity of 14,000 gallons. The liquid was received into a second tank, and after aeration was distributed over a meadow and vineyard and further purified by filtration through the
soil. These works are described in the proceedings 3381
of the Institute of Civil Engineers, Volume 78, page 502, and are of interest as showing the adoption of the automatic scavenger of Mouras on a large scale.

On July 3, 1883, Silas Wilcox took out U. S. patent No. 580,545, for an Improved Form of Grease
Trap. His drawings show a tank protected from 3382
light and air with submerged non-disturbing inlet and outlet and divided at one end by a baffle wall.

In 1883 Dr. Sorby remarked on the very large proportion of the detrius of faeces which was lost in the River Thames, owing to the action of countless thousands of living creatures.

In 1884 the installation testified to in this case 3383
by Mr. W. S. MacHarg, at Altenheim, Chicago, was made. This installation as well as many others of similar type, which have been made in this country in the last twenty years, may, in my opinion, be all traced to the discoveries and writings of Colonel George E. Waring, as noted in my testi-
mony before. 3384

In 1884 Robert Warrington read a paper on nitrification at the 54th meeting of the British Association of Agricultural Science, at Montreal, P. Q., and in which he reviewed the subject and described the nitrification of organic waste in soils. He complains that evidence of this ferment should no longer be neglected.

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In 1884 Professor E. Franklin read a paper before the British Association for the advancement of science, page 681, on chemical changes in their relative organisms. Also in 1884 a German scientist, Eberth, together with Gaffky and Koch, discovered the baccilus of typhoid fever, DuPre, in a
3386 report to the local government board of England, of the results of experiments on aeration, states that the consumption of oxygen from the dissolved air of a natural water is due to the presence of growing organism, and that in the complete absence of such organism little or no oxygen would thus be consumed. He further states that living organ-
3387 isms were essential to the destruction of sewage.

Thus, from these last citations, it will be clearly seen that the art of bacteriology was fully put upon its feet in the years from 1880 to 1884, and that not only was it understood among a few scientists who had conducted experimental research, but that it was well published in the technical journals
3388 of the day. And it will be further noted that these articles indicate fully that the liquefaction of the solid matter in sewage were due to living microorganisms, thus establishing fully the origin and the nature of this important chemical reduction.

While these steps were being taken by an intelligent minority, and while the nature, character of
3389 liquefaction of sewage solids were fully demonstrated, nevertheless it was a fact at this time, especially in England, that the process of purification of sewage was being most extensively conducted along the lines of chemical precipitation, and that nearly all of the principal writers and important books of that day ignore the established facts

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which the intelligent minority had come into possession of. Chemical precipitation was being generally adopted by many of the larger cities, despite the fact that it was well known and fully tested in the instance which I have cited both in England and in America, that liquefaction of solids would
ensue, providing the sewage were brought to rest 3391
in tanks secluded from light and air, and with non-disturbing inflows and outflows, such as were in use by Waring, and earlier recommended by Henry Austin, patented by Dr. Alexander Mueller, and Louis Mouras.

This singular state of affairs somewhat obscure
the value and importance of the work that was 3392
being done to demonstrate the liquefaction of sewage, but that such work was being done, and was important, can be seen from the citations which I have made. Perhaps one of the greatest setbacks which liquefaction received was at the hands of the Royal Commission 1882 and 1884, who, notwith-
standing the known facts as to bactertial life and 3393
their activity in liquefying the solids of sewage, which was pointed out by the writer which I have cited, decided against the discharge of crude sewage into the River Thames and prescribed some process of deposition or precipitation the solid matters to be applied to the raising of low lying
ground, or to be burned, dug into land, or carried 3394
away to sea. This latter alternative having been adopted for the City of London, together with a preliminary chemical precipitation many smaller municipalities followed the example of the City of London by adopting similar means of sewage purification. And in England, for perhaps ten years

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sewage purification by means of chemicals were the only methods which the superficial observer could prominently find.

In the United States no such marked setback to natural methods has been observable. The early work of Colonel Waring from 1880 on developed
3396 the so-called macerating tank, in which he recognized the principle of dissolution of solids by bacterial action, not all at once, but gradually in the course of six or seven years following his patent of 1880. Colonel Waring being a writer of great popularity, was enabled to spread the knowledge of this form of action very broadly over this country, and had
3397 many imitators who followed sewage purification along the lines which he laid down. Save in one or two instances where cities studying the sewage purification problem had been led to look to English practice, no large number of chemical purification plants were installed, and it is safe to say that prior to 1890 in this country the majority of
3398 sewage purification plants, both large and small, followed along the lines which Colonel Waring had laid down in his early books of 1876 and 1884.

Even in the later work in this country in which intermittent filtration had been extensively adopted, the ideas of Colonel Waring are seen to survive in many places in the adoption of tanks so arrang-
3399 ed as to receive the solids of the sewage, and retain it a suitable length of time until it has become, to use his own expression" macerated and dissolved."

In 1885 Dr. Emmich experimented in Germany on the changes which occurred in water and sewage on exposure to air. He said when left standing and after agitation with air the self-purification only took place if the water had not been sterilized through boiling, and had not been protected against the entrance of germs during the period of observation, (Chem. Centrabatt for 1885).

In 1885 Robert Corscadn, took out U. S. patent, No. 315,912, for collecting and drying sedimentation matters in sewage. In his arrangement he pro- 3401
vides two deep catch basins for sedimentation with non-disturbing inflow and baffle wall. These patents are merely cited to show how common to the art were the contrivances for retaining the solids of sewage in tanks, so that they might be dissolved and liquefied.

In 1885 Mr. Rudolph Hering, sanitary engineer 3402
of New York City, installed for the Sagamore Hotel at Green Island, Lake George, a plant consisting of a macerating tank practically air and light tight, with submerged inlet and outlet and dividing wall, the effluent from which after being aerated in a flush tank, was distributed upon a filter field. This installation, like the others which I have cited 3403
in this country, show distinctly the influence of the ideas of Colonel George E. Waring in his publications of 1876 and 1894, in which such macerating action, so-called, is fully described.

In 1886, Messrs. Gay & Dupetit published a research upon the reducing of certain individual species of bacteria, and the reduction to nitrates 3404
they find to be the usual property of bacteria, (British Association for the Advancement of Science, page 653).

In 1886 it was said, before the English Society of Arts, that during spontaneous subsidence, which is a much slower process than precipitation, fer-

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mentation sets in, solids are converted into liquid and both solids and liquid into gases, and Dupri proposed before the Society of Arts to cultivate the low organisms on a larger scale and discharge them with the effluent of the London tanks into the river, as the power of those low organisms to reduce sol-
3406 ids of sewage was remarkable.

In 1886 also, Messrs. Gay & Dupetit investigated the change of nitrates with the evolution of nitrogen oxides and nitrogen gas by the agency of bacteria. Two organisms were isolated from sewage which in the presence of organic matter decomposed nitrates with the production of nitrogen and
3407 nitrous oxides, (Journal Society of Chem, page 1160, December, 1898).

In 1887 Dupri at the Sanitary Congress of Bolton, England, said: "Whatever scheme may be adopted, except the destruction of sewage material by fire, the agents to which the ultimate destruction of the sewage is due are living organisms, not
3408 necessarily micro-organisms, either vegetable or animal. Our treatment should be such as to avoid the killing of these organisms, or even hampering them in their actions, but rather to do everything to favor them in their beneficial work, (Sewage by Samuel Rideal, page 177).

In 1887 Garre in Corresp. Fur. Schweizer Aertze,
3409 demonstrated the antagonism for certain bacteria for each other which under certain conditions prevent fermentation, (Sewage by Samuel Rideal, page 81).

It is evident from a research of these scientists that not only was the bacterial activity in fermentation and decomposition being actively studied, but that liquefaction was well understood to such as cared to read what they had written.

In 1886 the legislature of Massachusetts committed the general oversight and care of inland water to the state board of health and conferred upon it power to employ experts, advise towns and make experiments. The impetus which this action 3411
of the Massachusetts legislature gave to the art of sewage purification in this country was very great, and the experiment station of the Massachusetts State Board of Health became of great interest to all sanitarians. The obvious methods of disposal in the section of the country which came under its influence were not such as to cause the State Board 3412
of Health to investigate the methods of liquefaction, in aeration, introduced by Colonel Waring, Phillbrick, Dr. Alexander Mueller, Louis Mouras, and others. An abundance of cheap, sandy soil existed throughout the New England states, which gave promise that land methods of filtration would be the most successful from a financial standpoint. 3413
Accordingly the Massachusetts State Board of Health devoted its attention and experimental work to the filtration of sewage through sand, and developed knowledge which made that method of sewage purification pre-eminently successful in the New England States, to the exclusion of other methods of liquefaction in the preliminary stage 3414
which had been adopted elsewhere. But the work of the Massachusetts State Board of Health being very prominent in this country, did, for a time, somewhat obscure the earlier work of Colonel Waring, Edward Phillbrick and their followers until today it is not readily appreciated what a large

part Colonel Waring had in independently discovering and applying liquefaction methods as a preliminary state of sewage purification. As I have before said, remnants of his ideas exist, even in the sewage purification plants of New England, installed under the auspices of the State Board of Health in the
3416 adoption of preliminary macerating or separating tanks.

In 1887 the city of Medfield, Massachusetts, installed a purification plant which is described in the 19th Annual Report of the Massachusetts State Board of Health, page 100, also in a publication entitled "Sewage Disposal in the United States,"
3417 by Messrs. Rafter & Baker, page 490.

Adjourned till tomorrow, Wednesday, September 6, 1905, at 10 o'clock A. M.

Wednesday, September 6, 1905, 10 o'clock A. M.; met pursuant to adjournment; present as before.

The witness resumes his answer as follows:

3418 The works at Medfied, were designed by Mr. Elliott C. Clark, a civil engineer of Boston, and were approved by the Massachusetts Board of Health in August, 1886. I quote from page 490 of Rafter & Baker's book the following description:

"Much ground dyewood is used at the straw works * * Accordingly to exclude the spent
3419 dyewood from the sewer there was built adjacent to the dyehouse a settling basin with a filter whose construction may be understood by the aid of the accompanying drawing. It was made in two parts side by side, exactly alike, in order that one-half may be in use if necessary while the other is being cleaned out. The discharge from the vats can be turned by a wooden gate in a trough which brings it from the dyehouse into

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either side of the settling basin separately. Entering by the four-inch openings the liquid flows generally in both sides with a total width of ten feet and a depth of four feet less the thickness of the deposit of sediment. The velocity of flow is thus checked and the ground dyewood has a chance to settle.

To get into the second pair of compartments 3421
it has to pass over the brick dividing wall whose elevation is the same as the bottom of the inlet pipe. Here is another opportunity for settlement to take place, but apparently very little collects in the second compartments until the first are pretty well filled. In the third compartments by a tight board partition the liquid is obliged to pass downward and escape by upward filtration through a mass of excelsior held between two
sets of wooden slats as exhibited in the drawing; 3422
the upward flow being preferred as a precaution against choking the filter.

The filter was in use nearly a year before the excelsior was changed; it worked very satisfactorily, but the excelsior had by that time become so rotted that probably it would soon after have gone to pieces and escaped through the sewer. A new supply was accordingly substituted.

The sediment needs to be shoveled out and 3423
carted off once or twice a year. It has a similar appearance to sawdust except for its black color.

Near the lower end of the sewer the sewage passes through a cesspool arranged as shown on the accompanying drawing (Fig. 80), so that the outflow takes place from beneath the surface of the sewage standing in the cesspool.

The effect is that objects which either float or 3424
sink are held back until they are sufficiently changed by chemical or other action to flow uniformly with the rest of the liquid and are prevented from being thrown out on the ground at the outlet.

Very little sediment collects in the cesspool, only about a foot in depth in the course of a year; when it fills up the sediment will have to be filled out."

The description is accompanied by a drawing a copy of which is in evidence in this case, marked "Medfield Filtering Tank". This drawing shows a covered tank practically air and light tight, and bafflle walls so arranged as to substantially prevent disturbance of the contents by the inflow and
3426 outflow.

This significant description would be practically identical with the description of the septic tank of today substituting only the name of septic for filtering tank, settling basin and cesspool.

The description further shows that the capacity of the tank is about 7,000 gallons, and that the flow
3427 as given at that time would occasion a detention in the tank of about 8 hours, a sufficient period to cause the liquefaction of the solids by anaerobic action especially in view of their further retention by means of a bafflle wall and arrangement of the excelsior filter near the outlet.

A further description of this plant may be found
3428 by Mr. Brooks in the journal of the association of engineering societies, volume 7, No. 7, pages 235 to 244, for July, 1888; also in the Engineering and Building Record, Volume 18, pages 27 to 30, 1888.

Mr. Elliott C. Clarke was a sanitary engineer of high repute in Boston, who, in his ideas and practice, followed closely the ideas of Colonel George E.
3429 Waring heretofore alluded to.

The year 1887 witnessed considerable activity in sewage purification matters. Mr. Dibdin, in England, read a paper on sewage precipitation, in which he says: "One object claimed for the use of an excessive quantiy of lime * * * * is that it destroys the living organized bodies such as bacteria, etc., which give rise to the phenomena known as putrefaction.

As the very essence of sewage purification is the ultimate destruction or resolution into other combinations of the undesirable matters, it is evident that an antiseptic process is the very reverse of the object to be aimed at." 3431

This significant language from the very chemist who had in 1884 reported for the local government board in favor of the chemical purification of London sewage shows the beginning of an awakening to a reaction against the chemical processes which were at this time so much in vogue in England. Mr. Dibdin's attention was evidently thus turned at this 3432
time to the processes of bacterial liquefaction and observation which he developed by means of experiments which we will later refer to.

Mr. Dibdin in the same year in a paper read before the Institution of Civil Engineers, says: "Bacteria are most potent in sewage purification," and he prophesies that aid in the cultivation of bacteria 3433
will be found to be the final solution.

In the year 1887 Robert Warrington also read a paper before the British Association for the Advancement of Science, page 653, entitled "The Reduction of Nitrates by Micro-organism."

Also in the year 1887 foecal matter was admitted to the Paris sewers for the first time, thus doing 3434
away with the necessity for the automatic scavengers of Louis Mouras.

In 1887 also the Massachusetts State Board of Health gave a description of a decomposition tank in the 19th Annual Report, page 101, which is quoted in his testimony by Mr. Snow, typewritten

3435 page 210. In this description the significant language is used as follows: "The effect is that objects which either float or sink are held back until they are sufficiently changed by chemical or other action to flow uniformly with the rest of the liquid, and are prevented from being thrown out upon the
3436 ground at the outlet * * * Very little sediment collects at the cesspool, only about one foot in depth in the course of a year. When it fills up the sediment will have to be taken out."

This seems to me to have been clearly the intentional utilization of the liquefying process, and its recognition by the Massachusetts State Board of
3437 Health, in spite of the fact that their later experimental work was devoted to other lines of study. I attribute this recognition, together with the approval of the Medfield design, to the influence of Colonel Waring's ideas upon the Board.

In the year 1887 United States patent No. 366,-333, was taken out by Albert T. Marble and George
3438 W. Knapp, for Purifying and Aerating Sewage. The apparatus consisted of large settling tanks with an outlet from the bottom, and aeration produced by a weir in combination.

On August 2nd, 1887, United States patent 367,-576, was taken out by George A. Allen, for an improved water system, which improvement consisted
3439 in assuring the discharge of the water from the level below the surface thereof and above the bottom of the tank, to avoid the passage of either surface scum or impurities, or sedimentary deposits into the discharge pipe. The outlet consists of a flowing conduit or compartment having a series of slots or openings in its wall. These openings

deliver the water from the tank into the said chamber and thence into the outlet pipe.

In 1887 Wilhelm Gurtler took out British patent No. 7134. The appliance consisted of a tank with a submerged non-disturbing inlet and outlet chamber and a series of apertures above the bottom and
below the top for the purpose of preventing the es- 3441
cape of surface scum.

In 1888 it was said by a German scientist O. Loew (Pflugers Archives 27, page 203) that ferments in human faeces allied to diastase or invertase were investigated, and their hydrolycis found to be very rapid, so that very little trace of them is
found after a short time. (Sewage, by Samuel 3442
Rideal, page 92).

In 1888 began the experiments of the Massachusetts State Board of Health which were authorized by the law which I have before mentioned. These experiments, as I have before stated, temporarily diverted attention from the
liquefying and macerating tanks which had been 3443
worked out by Colonel George E. Waring.

In 1888 appeared the book entitled "Sewerage and Land Drainage," by Colonel George E. Waring, published in New York by D. VanOstrand & Company. Several editions of this book were published in the years following. I have an
edition marked 1891, which I have carefully com- 3444
pared with the 1888 edition and find them identical except as to the title page.

In this book Mr. Waring reviews the subject of sewage purification at length and emphasizes his earlier ideas. Mr. Benezette Williams in this case has quoted liberally from Mr. Waring's book and I will not here repeat those quotations.

I desire, however, to call attention to a marked peculiarity of all Colonel Waring's work, which I think is especially significant. In drawing ideas from English engineers Mr. Waring emphasizes always and everywhere in his book the necessity of preventing injurious decomposition
3446 from taking place in the sewage and of providing suitable means for its rapid removal after formation to a considerable distance from its origin to such points as may be selected for its final disposition. Colonel Waring's well-known advocacy of a separate system of sewers especially designed for this purpose caused him to reiterate
3447 this principle in many different and varied ways in his numerous writings.

Now, it is especially significant to me that in spite of his adoption of this well understood principle, Colonel Waring was compelled to admit, as he frankly does in the quotations made from his book by Mr. Benezette Williams in this
3448 case, that under some circumstances in suitable air and light tight tanks with non-disturbing inflow and outflow decomposition, or as we now call it, septic action, might properly take place without offense and by which action, which he did not attempt to fully explain, actual reduction of the solids of the sewage were effected with the
3449 practical result that such tanks seldom needed to be cleaned and sometimes operated without the necessity of any cleaning whatever.

Colonel Waring himself seems to have felt the incongruity of this idea with his repeated and oft-mentioned warnings against decomposition in general, and apologizes in a measure for the apparent opposition of his own views.

It seems to me that this is especially significant, and I desire to point out that the evidence of Colonel Waring's discovery of liquefaction, or as he would have called it, maceration, is thus rendered exceptionally strong, from the fact that in discovering it he was apparently violating one
of his own long cherished principles and be- 3451
liefs.

In 1889 there was installed in the Massachusetts School for the Feeble Minded at Waltham, Massachusetts, a sewage purification plant consisting of a sludge trap patterned after the ideas of Colonel Waring, following which was a de-
taining tank from which the fluid was aerated by 3452
means of a flushing siphon and delivered to an irrigation field. A description of this plant may be found in the book entitled "Sewage Disposal in the United States," by Rafter & Baker, page 507; also in the Engineering and Building Record, Volume 21, page 300. I quote from Mr.
Baker's book, at page 507: 3453

"The plan prepared by Mr. Johnson and carried out was as follows: From the Custodial Ward building asd the laundry just south of it the sewage is conducted into a brick sludge-trap, shown in detail by Fig. 89, where it halts until the grease has risen in a scum to the surface, the insoluble matter settled to the bottom, and the
paper, etc., became broken up and held in suspen- 3454
sion. The 6-inch inlet enters about a foot above the surface of the sewage. From the sludge-trap a 4-inch ventilating pipe runs into the boiler-house chimney. The 5-incn iron overflow from the sludge-trap to the detaining tank is T-shaped, and so placed as to allow the effluent to pass over from below the scum of the grease on the surface and from above the sediment at the bottom of the sludge-trap. An 8-inch iron pipe

and gate at the bottom of the sludge-trap permits the grease and sediment to be run off to a compost heap as often as may be necessary, probably about once in three months.''

In 1889 at Frankfurt, Germany, these works were described by Mr. Lindley in Volume XCVI of the minutes of the proceedings if the Insti-
3456 tute of Civil Engineers, in 1889, page 292,293. A quotation is made quite fully by Mr. Snow in his testimony typewritten page 73, and I will point out that it seems to describe very completely a tank which must of necessity have produced liquefying action.

It appears that the designers of such tank as
3457 this had fully in view that some distinct gain was made by causing the sewage to come to a state of rest so that floating solids were retained within the tank; and although means were provided for removal of the sludge as they practically have to be provided in the septic tanks of today, yet reducing action was expected of such
3458 tanks in accordance with the scientific studies and ideas which I have pointed out were possessed by the small minority of thinkers all this time.

Unfortunately most of these tanks have been described by ardent advocates of chemical precipitation, who have either failed to understand
3459 the intention of the designer, or themselves not kept pace with the progress of science, as regards the liquefaction of the solids of sewage. This is notably the case in England, and particularly true of the work of Mr. Santo Crimp, who was an enthusiastic advocate of chemical precipitation.

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In 1890 Messrs. Brown and Morris (Transactions Chemical Society, 1890, page 497) isolated from fungi a ferment called cytase quickly dissolving celluloses. In this work they corroborated upon Von Senus who, in 1890, proved the fermentation of fiber to be anaerobic, that it was occasioned by symbiosis or concurrent action of several or- 3461
ganisms, and that gaseous products remained. Ven Senus isolated an enzyne that dissolves fiber, also a group of the resolving bacteria from mud, stomach contents and decaying vegetable matter. (Sewage by Samuel Rideal, page 91).

In 1890 Dr. Armstrong, in a paper read before the Transactions of the Chemical Society, for 3462
June, 1890, page 528, proposed the term Zymosis for fermentation by living organisms, and enzymes or unorganized ferments (Sewage by Samuel Rideal, page 83).

In 1890 there was published by Van Ostrand & Company, New York City, a book entitled "The Disposal of Household Wastes," by Wil- 3463
liam Paul Gerhard, a civil engineer of New York City. In this book will be found, pages 75 to 79, a description of liquefying tanks similar to those earlier recommended by Colonel George E. Waring, and consisting of a closed tank practically air and light proof with submerged nondisturbing inflow and outflow, baffle walls for 3464
retaining the scum, and aeration by means of a weir over which the effluent from the tank flows. Descriptive cuts of these appliances will be found on page 180 and page 184.

In 1890 Messrs. Adney & Perry took out British patent No. 3312 for keeping sewage under

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conditions favorable for rapid multiplication of micro-organisms, soluble inorganic compounds being added to assist the action.

This patent has been examined and quoted by Mr. Snow in this case, typewritten page 76, and I would only point out that in its description it
3466 shows a clear appreciation of liquefaction by anaerobic action, as a preliminary stage in sewage purification. And some of the necessary apparatus for detaining solids, so that such action could take place.

April 1st, 1890, United States patent No. 424,-838, was taken out by Frank L. Union for an im-
3467 proved cesspool for separating solids. The appliance shows a covered water-tight tank substantially air and light-proof, a non-disturbing inflow and outflow and dividing wall. The apparatus is substantially that used and recommended by Colonel George E. Waring in his earlier writings; and is evidently intended to take
3468 advantage of the liquefying action of anaerobic bacteria. A very large installation was made on this system at the Danverse State Lunatic Asylum in Massachusetts; also at Milford, Massachusetts, and for many private houses.

In 1891 at Gardner, Massachusetts, there was installed a sewage purification plant which con-
3469 sisted of allowing the sewage first to enter two tanks seven feet wide, twenty feet long and five feet deep, there to remain at rest during which time the solid matters were settled and separated from the liquid. These tanks had an outlet below the surface of the liquid at mid-depth, and contained about 10,000 gallons of sewage

when full. A description of this plant is found in a book entitled "Sewage Disposal in the United States," by Rafter & Baker, page 516. From this description it is found that the flow through the tank amounted to about 125,000 gallons a day in 1893, which would allow a period of retention in the tank of about two hours. A sufficient period, in my opinion, under favorable circumstances, for anaerobic action to take place tending to reduce the solids, especially in view of the baffle walls and other features provided for the purpose of retaining such solids within the tank. 3470 3471

In 1891 Professor L. Pagliani, professor of hygiene and director of public health in Rome, Italy, read a paper before the Seventh Congress of Hygiene and Demography, held in London, in 1891, in which he describes his application of a reservoir interceptor made on the Mouras type and connected with a peat filter. A considerable quotation from this paper was made in Mr. Snow's testimony in this case, pages 59 and 60, which I will not here repeat except to observe that Professor Pagliani seems to have had a clear idea of the liquefying action of anaerobic bacteria upon the solids in sewage, and the means to be provided in tanks intended for this purpose. Professor Pagliani goes into the method of operation of such tanks in some detail and mentions three instances of the use of these tanks on a large scale at Rome. 3472 3473 3474

In 1891 Professor J. W. Dibdin began experiments at Barking, near London, on the bacterial purification of the effluent from the precipitation

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tanks of the London purification plant, thus carrying out ideas expressed by him in 1887 as to the reduction of solids in sewage by micro-organisms.

In 1891 also Mr. Scott Moncrief began experiments at Ashted in Surrey, England, with a bac-
3476 terial tank in which the sewage entered at the bottom and passed with an upward flow through a certain coarse material, such as broken stone, etc., his idea being that those broken stones would serve as fixed surfaces upon which the putrefying bacteria could live; and he called his tank a cultivation filter. (Sewage by Samuel
3477 Rideal, page 229.) Reports on this tank and analysis were published in 1893 by Dr. Houston, and will be mentioned later.

In 1892 there appeared an account of the process as described by Mr. Moncrief in the Pall Mall Gazette of September 24, 1892, which has been quoted by Mr. Snow in typewritten page 62 of
3478 this case. Also an article in the Suffolk Times of September 30th, 1892, describing the process, which has also been quoted in typewritten page 62 in this case by Mr. Snow. Also in the Engineer of October 14, 1892, a publication having its offices in London, which quotation will be found on typewritten page 63 of this case by Mr. Snow.
3479 Also a description in the Hampshire Advertiser, of July 26, 1893, which has also been quoted by Mr. Snow on typewritten page 63 of this case. Also in the Builder of London, of August 12, 1893, and Industries and Iron, October 6, 1893, which are quoted by Mr. Snow on typewritten page 65 of this case.

I will not repeat these quotations, but will merely point out in passing that they are all clear and concise statements of the art of purifying sewage by a preliminary stage in which micro-organisms liquefy the sewage after it has been brought to rest in suitable tanks or other
receptacles containing apparatus for retention of 3481
the solids by means of non-disturbing inflow and outflow. Mr. Scott Moncrief was granted a patent which I will notice later.

In 1892 the Flush-Tank Company of Chicago published a catalogue which has been testified to in this case by Mr. Benezette Williams, and which
describes apparatus for the purification of sew- 3482
age, the first stage of which consists of a retention of the sewage in tanks with non-disturbing inflow and outflow, baffle walls for retention of the scum, and practically air and light-tight. The effluent, on leaving the tank, is to be aerated over a weir in a flushing chamber and afterwards pu-
rified by filtration. The apparatus described in 3483
this catalogue follows strictly the lines laid down by Colonel George E. Waring, which developed in the patent in 1880 for an improved grease trap and flush tank, and the results noted therefrom in his book of 1876 hereinbefore described, and his later works of 1888 and 1891. Mr. Williams has
very fully described the operations of the Flush- 3484
Tank Company and I will not undertake to go into them fully except to say that a good many installations made by this company have come under my notice in various parts of the country and have appeared to be working well and giving good satisfaction.

In 1892 there was installed a sewage purification plant at Marlborough, Massachusetts, which is described in the book entitled "Sewage Disposal in the United States," by Rafter & Baker, page 504, and illustrated with plates. This plant is also described in Engineering News, a publica-
3486 tion of New York City, in Volume 27, page 170, for August 25, 1892. It appears from the description in Rafter & Baker's book that the sewage first passed through settling tanks in which there were located baffle walls and a screen, and that the outlet from such tanks made in such a manner that the scum or floating solids at the surface
3487 and bottom of the water would not be permitted to flow out. I quote from page 505: "A separating or settling tank removes the sludge of the sewage, after which it passes through iron pipes to the filter beds. * * * * It is of brick of two compartments, with gates permitting sewage to be admitted to or drawn from either one at
3488 will. The course of the sewage in passing through the tank is shown by the drawing. The screens perform only a slight service, as most of the solid matter settles before the sewage reaches the screen. The sludge can be removed from either tank to the sludge carrier by opening the cleaning-out gate." It appears from the quo-
3489 tation that the capacity of the tank in its proportion to the amount of sewage flowing in 1892 was such that the contents of the tank would be theoretically changed in about one and a half hours, but by means of the baffle walls and screen the solids of the sewage were, of course, retained a very much longer time than this. It is my opin-

ion that under these circumstances some degrees of liquefying action would obtain, and I base this opinion upon observation of similar tanks with about the same proportion of flow.

In the plant at Marlborough the tank is followed by aeration and filtration, and it would appear to me that the introduction of the tank in 3491
the manner shown is a survival of the ideas of Colonel Waring, which appears in much of the work of the Massachusetts purification engineering, which are ostensibly intermittent filtration systems in their nature.

In the report of the Massachusetts State Board of Health in 1893 appears a description of a num- 3492
ber of such plants which I have referred to, on page 560 and following.

In 1893 Mr. Scott Moncrief read a paper before the South Midland Branch of the British Medical Association, held at Towcester, October 13, 1893, in which he describes the liquefaction of the solids by bacterial action, and the nature of 3493
the tank which he has adopted for that purpose.

In 1893 also Mr. Percy Frankland, in England, in a report to the British Association for the Advancement of Science, page 441, entitled Bacteriology in its Relation to Chemical Science, shows that ferment preceding the exhaustion of dissolved oxygen is responsible therefor, and is 3494
bacterial in origin, and that upon the exhaustion of oxygen, only anaerobes and facultative bacteria survive necessarily.

Also in 1893 Dr. Houston made a report on Scott Moncrieff's process at Ashtead (Sewage by Samuel Rideal, page 229).

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In 1892 Earnest Edgar Sculby obtained United States patent 484,823, for Apparatus for Purifying Sewage. This apparatus shows a tank B connecting by a pipe C to an aerating chamber, which chamber is air-tight into the upper part of which the sewage is led by the pipe C and
3496 then showered or broken up into spray as much as possible by means of a showering plate which may be coned or semispherical or of other suitable form.

September 19, 1893, Oluf E. Meyer obtained United States patent, 505,166, for sewage apparatus, comprising a series of tanks containing
3497 divisional walls, baffle boards and submerged outlet, combined with filters and aeration.

In 1892 Elmer St. John obtained United States patent No. 478,654 for an improved catch basin, showing the submerged inlet and outlet.

In 1894 a sewage purification plant was installed in Oberlin, Ohio, described in the Engi-
3498 neering News of September, 1905. This plant consisted of two settling basins, each ten feet by thirty feet in area, and three feet deep, having a capacity of about 13,000 gallons.

In 1894 Frank Pullen Candy took out British patent No. 8671 for Improvements in Upward Flow Precipitation Tanks. This descrip-
3499 tion shows a submerged inlet, equal distribution and aeration.

In 1894 Professor A. N. Talbot constructed an experimental tank at Urbana, Illinois, which he has testified to in this case, and which is known as the "Urbana Tank," and which he has traced in its conception to tanks at Wellesly College and

to suggestions made to him by the automatic scavenger of Louis Mouras. In articles subsequently published, which will be later referred to. Prof. Talbot used the term "Sedimentation and Subsidence" to cover process for which the popular conception had as yet become familiar
with no term adequate to describe what action 3501
really went on. In the same way the word "filter" has come to be used to cover many kinds of installation in which filtering proper has no part, and it has remained for Mr. Cameron, of Exeter, to coin a word which has caught the popular fancy and has been generally adopted by
sanitarians in consequence. I refer to the use 3502
of the word "septic" to describe what I have heretofore termed as liquefying of solids, what was early called by Colonel Waring maceration of solids, what has been described by Mouras and Dr. Alexander Mueller as fermentation, and what was called by Professor Talbot Sedimentation and Subsidence.

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In 1894 Professor Talbot installed at Champaign, Illinois, what is known in this case as the First Champaign Tank, and later designed a second and permanent tank for Champaign, which was built and put into operation in 1897. The drawings and descriptions of these tanks are
very fully spread upon the records of this case 3504
and I will not allude to them further here, save to note that they contained the essential features for promoting anaerobic bacterial action in the detained solids within the tank, such arrangements consisting of practically air and light-tight covers, non-disturbing inlet and outlet, and sub-

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sequent aeration. The flow of sewage into these tanks bore such ratio that the time of retention of the sewage would be at least from one to four hours, and of course being detained by baffles and deposition upon the bottom, had a very much longer time than that in which to be subjected
3506 to the liquefying action of the anaerobic bacteria. I have on several occasions inspected the working of the second Champaign tank and found it satisfactory.

In speaking of the terms non-disturbing inflow and outflow, I would suggest that these are relative terms only, as it is not possible that liquids should
3507 flow into a tank and absolutely create no disturbance under any circumstances. It is therefore perceived that in using these terms there is meant such a degree of non-disturbance that the life and activity of the anaerobic bacteria whose office it is to liquefy the solids shall not be seriously retarded.

In speaking of liquefaction as a process requiring
3508 appreciably little time I do not wish to be understood as expressing the conviction that measurable time is equally applicable to all conditions and circumstances. What may be conducive to rapid bacterial action under one condition of temperature and flow may not be so conducive under other circumstances, and it is my conviction that no limits
3509 can be placed in measurable time upon what constitutes reasonable anaerobic bacterial activity in the liquefaction of solids.

The process of breaking down complex organic matter commences, in my opinion, so soon as the wastes of life have been created, and are bound to continue in the ordinary process of nature unless

interrupted by sterilization induced by extreme heat or antiseptic chemicals. Under such circumstances, therefore, it is not possible to say that liquefaction does not progress in any given tank, however, short the periods may be, in which the sewage is brought to a state of rest within the tank.
Such liquefaction may be seriously retarded by the 3511
rapid accumulation of solids, due to the small size of tank in proportion to the flow of sewage, but it cannot, in my opinion, be wholly stopped, and there is, therefore, in my opinion, no possible line of demarcation between a tank intended for the liquefaction of solids and one intended for plain sedimentation. Indeed it appears to me that in all plain 3512
sedimentation tanks however operated always providing antiseptic chemicals are not added, some considerable reduction of organic matter must take place.

In October of '95, Mr. J. W. Dibdin made his report on the experiments at Barking to the London County Council in a pamphlet entitled, "Report by 3513
the Chemist on Experiments on the Filtration of Sewage Effluent During the Years 1892, 1893, 1894 and 1895." The publication of these experiments produced a widespread interest among engineers everywhere, both in England and America, and caused a renewal of study of the rapid bacterial methods in sewage purification among many sani- 3514
tarians who had not before given the subject much attention.

On December 11, 1894, Mr. W. D. Scott Moncrief, took out United States patent, No. 530,662, for the treatment of sewage and apparatus therefor, which had for its object to purify sewage and discharge

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a clear inoffensive effluent. This, it was clearly
stated, was accomplished by the action of microbes
which liquefy and break up the organic matter of
sewage. A very full quotation from this patent is
made by Mr. Snow in the evidence in this case type-
written pages 89 and 90, and will not be repeated
3516 by me here, only so far as necessary to observe that
the description is a clear and exact statement of the
operation of what we know now to be liquefaction
by micro-organisms.

The invention provides for the treatment of sew-
age by what is now called septic action combined
with filtration and aeration.

3517 On March 17, 1896, Mr. Frank L. Union obtain-
ed United States patent, No. 556,596, for the Aera-
tion and Filtration of Sewage after the solids and
semi-solids have been separated therefrom. This
patent, therefore, combines aeration and filtration
with any previous treatment of the sewage for the
removal of the solids therefrom.

3518 We have seen heretofore that the science of bac-
teriology was revolutionized and well established
between the years 1880 to 1884. We have followed
the fact that in England for the decade prior to
1890, the disinfection of sewage by chemical pre-
cipitation was largely in vogue, and that the ef-
fort to introduce bacterial knowledge in sewage
3519 purification was confined to the minority. We have,
however, traced the fact that even in England the
minority were actively engaged in carrying out
their ideas, and that while they frequently had
their plants described by those who were opposed
to their ideas, such as Santo Crimp and others,
nevertheless their designs speak for themselves, and

show that some beneficial action by them then not easily explained, was expected from tanks in which plain subsidence was used, and the solids separated from the liquids of the sewage. We have also followed the work of Dr. Alexander Mueller, and Louis Mouras, and shown that their ideas, especially
those of Mouras, were put into practical operation 3521
abroad. We have developed the fact that Professor Pagliani in Italy had received from some source, we do not know where, but in all probability from the work of Mueller, Mouras, and others, the definite conception of the liquefaction of the solids in sewage by anaerobic bacteria in suitable tanks ar-
ranged for the purpose, and that several actual 3522
working plants which had been installed with this idea in view are mentioned by him.

We have seen how the gradual educational work of the bacteriologists had made its impression on sanitary engineers so that they began to turn their attention to the bacterial purification of sewage as
evidenced by the remarks of Professor Dibdin in 3523
1887 which I have quoted, and the experimental work of the London County Council.

In this country we have traced the early perception of Colonel Waring of liquefaction due originally to the introduction of the combined grease trap and flush tank for ordinary house sewage, which
brought to his observation and others who used his 3524
ideas the fact that the solids in such an arrangement were macerated and caused to disappear. We have seen that his ideas were published as early as 1876 and enlarged and elaborated in 1888 and 1901 in published books; we have observed that as a popular writer he was enabled to spread these ideas

broadcast, and that they were followed by many sanitary engineers, such as Elliott C. Clarke, Professor Phillbrick, Mr. Benezette Williams, Mr. W. S. MacHarg, and numerous others, and that they practically formed the nucleus of all of the early sewage purification work in this country.

3526 We have seen how those ideas of Colonel Waring
became partly obscured by the work of the Massachusetts Board of Health in carrying on the experiments devoted almost exclusively to the purification of sewage by sandy soils such as exist in great abundance in the New England States we have seen how the wide publicity given to this work brought
3527 sewage purification problems prominently before
the country, and to many engineers to whom the science of sewage purification as a problem had never before presented itself, and who were ignorant of the earlier work of Colonel Waring along this line.

It was at this psyhcological moment in the history of the art, when attention had for several
3528 years been turned to bacteriology as a solution to
the sewage problem and when the fallacy of disinfecting sewage by precipitating it with chemicals had begun to be seen even in England, that Mr. Cameron, in my opinion, drawing his inspiration from the minority scientists whose work and writings I have here outlined began to experiment at
3529 Exeter, England, with closed tanks, similar to those
in use by Louis Mouras and suggested as early as 1852 by Henry Austin, and in common use in the United States through the work of Colonel Waring.

Mr. Cameron's first small tank was installed April 5, 1895, and was 12 by 15 by 2½ feet in dimensions,

 3530

and took the flow from thirty houses. Finding this successful in liquefying sewage, Mr. Cameron constructed a larger tank, and then a third tank which is the one commonly referred to as the Exeter tank.

In November 8, 1895, he filed an application for British patent, No. 21,142, which was accepted
April 25, 1896. A later patent was taken out, Brit- 3531
ish patent, No. 23,042, filed October 17, 1896, and complete specifications filed June 18, 1897.

In these patents, Mr. Cameron claims that the entire exclusion of light and air in combination will cause an entire disappearance of the solids in the sewage, a result which no tank, before his time,
had ever succeeded in accomplishing, except under 3532
the most exceptional conditions; and it may be added that no tank since this patent was granted, either built along the lines indicated by Mr. Cameron, or in any other fashion, has succeeded in accomplishing this result. The claims, however, for the complete disappearance of the solids, attracted
wide attention through Mr. Cameron's work and the 3533
introduction by him of a word absolutely new to the art of sewage purification, that of septic action, added to the popular interest and riveted for a time attention to his work to the entire exclusion of the earlier work of Waring, Phillbrick, Benezette Williams, W. S. MacHarg, and others of Colonel War-
ing's followers in this country, as well as the ear- 3534
lier works of Dr. Alexander Mueller, Louis Mouras, Professor Pagliani, and their imitators abroad.

It is agreed between counsel that to save repetition, all objections made in the course of the deposition of the Witness Snow and elsewhere, with respect to any

3535 of the publications or matters referred to in the foregoing answer may be understood as made here.

Q. 7. Please summarize in the briefest and clearest way possible such of the prior patents and pub-
3536 lications referred to in your previous answer, as in your opinion disclose or describe the process or apparatus of the Cameron patent, No. 634,423, sued on in this cause, or material parts thereof, limiting your answer to Claims 1 to 8 inclusive, 11 and 12 inclusive, and 20 to 22 inclusive of said patent—explaining points of similarity and difference, and giving reasons for any opinions you may express?

3537 A. Claim 1 of the Cameron U. S. patent, No. 634,423, reads as follows:

"The process of purifying sewage, which consists in subjecting the sewage under the exclusion of air, of light and of agitation to the action of anaerobic bacteria until the whole mass of solid organic matter contained therein becomes liquefied, and then subjecting the liquid effluent
3538 to air and light."

As I understand this claim, it is a process claim for the purification of sewage by subjecting the same to the action of anaerobic bacteria under the exclusion of air, light and agitation. This is continued until the whole of the solid organic substances become dissolved. The liquid effluent is then
3539 subjected to air and light.

I cannot see that this claim possesses any elements of novelty not heretofore well known and understood and practised in the art of sewage purification. The early tanks of Colonel Waring for the purification of household wastes embodied all of the features which are herein described. On

page 291 of his book, entitled "Sewerage and Land Drainage," published in 1891, is shown a drawing of a tank which, together with the written description as quoted in this case by Mr. Benezette Williams, shows that it was intended to subject the sewage to the liquefying action of anaerobic bacteria until the whole mass of solid organic matter 3541
contained therein became liquefied, then subjecting the liquid effluent to air and light. This was accomplished in the apparatus of Colonel Waring, by providing an underground tank practically sealed from light and air, with a baffle dividing wall across the center over which the sewage might flow, and in which tank the sewage might be brought to rest 3542
a suitable length of time for the liquefaction of the solids of its contents. Colonel Waring says, on page 290 of his book: "In some cases the decomposition is so complete that the chamber never accumulates much deposit." Again on page 236 he states: "As long ago as 1876, Pasteur, in his studies on fermentation indicated clearly the difference between 3543
decomposition taking place with full exposure to the air and that going on in liquids from which the air was entirely or mainly excluded." On page 238 he says: "The presence or absence of light is important. Nitrification is most rapid in darkness, and in case of solutions exposure to strong light may cause nitrification to cease altogether." Again, 3544
on page 289, he says: "These developments of the system, simple though they are, have been slowly worked out to meet a succession of difficulties which have arisen in practice. They have now had sufficiently long application and sufficiently extensive trial to make it prudent to assert the practical efficiency of this method of disposal. . . . . .

3545 It is impracticable to allow the discharge from kitchen or water closet matter, including paper, to flow directly into the flush tank; it would soon obstruct the siphon and so much of it as passed on into the drains would soon obstruct these. It is, therefore, imperative that such matters should be
3546 withheld until by maceration or by decomposition they will pass on in solution or in suspension in the liquid flow. Insofar as decomposition is necessary, the settling basin is in a less degree, subjected to the theoretical objections that are made to the cesspool. It is, however, to be considered that this settling basin, which is perfectly tight as to its walls,
3547 is so small that the volume of water passing through it takes up the products of decomposition and carries them into the drains before they assume a condition at all comparable to that of the permanent cesspool. It is found practically that the arrangement is inoffensive and safe."

German patent, No. 9792, granted to Dr. Alex-
3548 ander Mueller, of Berlin, clearly describes the subjection of the sewage under exclusion of air, light and agitation to the action of anaerobic bacteria, until the whole mass of solid organic matter contained therein becomes liquefied, and then subjecting the liquid effluent to air and light. He says: "The process herein described aims at the methodi-
3549 cal cultivation of those small leaven-like organisms to the liability of which modern science has traced the so-called self-unmixing processes, namely, acidification, fermentation, putrefaction, decay or the like, in accordance with the rules of physiclogy with a view to bringing them into requisition in the task of precipitating out the liquid waste sub-

stances or bringing about their complete mineralization (that is reduction to simple inorganic compounds) * * * * * Only in a very few cases will it be necessary to actually sow the seed of those leaven-like organisms; they will mostly develope in amply sufficient quantities from the numerless
germs in suspension in the atmosphere which are at 3551
all times ready to settle or colonize in suitable soil, while their growth is further induced by the organic admixtures which are added for the purpose of applying an adequate proportion of nutritive substances in the form of meat, blood, flue, gluten or human excreta, etc."

In Mouras' French patent, No. 144,904, taken out 3552
September 22, 1881, and in Scott Moncrief's patent, No. 530,622, and in British patent, No. 3312, of 1890, to Adney and Perry, are described apparatus for producing the action of anaerobic bacteria under the exclusion of air, light and agitation, so as to liquefy solid organic matter in the sewage. In
the Mouras patent the sewage was to be admitted 3553
to an air tight tank hermetically closed. The inlet was so arranged as to pass sewage into the body of the tank at mid-depth, and an elbow pipe likewise arranged served to discharge the sewage contained in the tank.

In the Mueller patent, the mechanical and struc-
tural arrangements required were three or four 3554
basins, as is stated " for the digestion and defication of the waste liquid. Altogether they should have a capacity for receiving a full day's output of waste liquid and provided with means for continuous admission and discharge. They are lifted out of the ground and receive a floating top cover of coarse

3555 material, such as straw, chaff, froth, scum, etc., so as to retard cooling and evaporation."

Mr. Scott Moncrieff says: "My invention relates to certain improvements in the treatment of sewage and the apparatus therefor, and has for its object to purify sewage and discharge a clear and
3556 inoffensive effluent. This I effect by the action of microbes, which liquefy and break up the organic matter in the sewage. * * *I had discovered that the total solid matter in the ordinary sewage can be dealt with as the actual food supply of the organisms if it is properly conveyed to them." The apparatus which he provides in a tank in the bot-
3557 tom of which there is a chamber arranged for the purpose of delivering sewage so as not to cause agitation, and the exclusion of air and light was effected by a covering of filtering material. In his tank there was an apparatus for the purpose of supplying air at times, but this could not prevent the action of anaerobic bacteria in the layers below.
3558 In the tanks mentioned by Professor Pagliani he states that he had proposed long since with practically good results a type of Mouras reservoir somewhat modified, and on page 2, "As in every Mouras reservoir mine has for overflowing liquid an opening but provided with a grate through which cannot
3559 pass directly those bodies in the reservoir. * * Experience has proven that such a reservoir can work properly without any inconvenience for a very long period, and perhaps indefinitely when to it is supplied an abundant flowing of water." The apparatus as described is similar to the tanks of Mouras in every way.

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The Adney & Perry British patent, 3312 of 1890, comprises the intentional utilization of liquefying organisms to destroy the solid matter in the sewage. In the third method described in said patent hereinbefore particularly mentioned the destruction of organic matter in the subsidence or incubation chamber can only be through the agency of organisms 3561
more specifically of the anaerobic species, as no chemicals are used in the third method.

In the Phillbrick article in Sanitary Engineer, of May 10, 1882, occurs a description of an apparatus for producing liquefactions of solid substances in sewage in which the following occurs:

"It has been found necessary to provide a tank 3562
or tight cesspool in which the solid particles of the sewage may become macerated and finally divided by fermentation before entering the distributing pipes."

Mr. Phillbrick was a follower of the ideas of Colonel Waring and his descriptive article, accompanied with cuts, was merely a part of the educational campaign which Colonel Waring had insti- 3563
tuted to disseminate information on that subject in this country.

Adjourned till Thursday, September 7, 1905, at ten o'clock A. M.

Thursday, Sept. 7, 1905, 10 o'clock A. M.; met pursuant to adjournment; present as before. 3564

Claim 2 of the patent reads:

"The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow from light, air and agitation until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the

3565 solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, and then subjecting said pool under exclusion of light and air and under a non-disturbing inflow and outflow to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved."

3566 This claim is similar to the first claim, except
that certain successive steps in the process of liquefaction are detailed, and the subsequent subjection
of the liquid effluent to air and light is not included.
The successive steps not indicated in the first
claim are specifically for a non-disturbing inflow
and outflow and the sustaining of the micro-organ-
3567 isms by the inflow until the solid organic matter in
the flowing sewage is dissolved.

It appears to me that the process thus involved
is not new in the art and is specifically covered by
the instances cited in my analysis of Claim 1. In
all of the instances there cited the inflow is to be of
such a character as to be non-disturbing, and the
3568 outflow is likewise arranged. This is accomplished
in the Mouras automatic scavenger by elbow pipes
which turn down beneath the surface. In the tanks
of Waring and Phillbrick by a similar contrivance,
and in the art generally it is often accomplished by
baffle boards placed across the tank directly in front
of the inflow or outflow. In fact in all tanks, wether
3569 for chemical precipitation or sedimentation, the
seclusion of the sewage in a broad pool with non-
disturbing inflow and outflow is common to the art.

With these additions I believe the quotations which I have made in connection with claim 1 disclose the art as it covers claim No. 2, so that claim 2 presents no elements of novelty.

Claim 3 in suit calls for:

"The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow, from light, air and agitation until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the in- 3571
flow serving to sustain the micro-organisms, then subjecting said pool under a non-disturbing inflow and outflow and under exclusion of light and air to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved, and then subjecting the liquid outflow to an aerating operation."

This claim is a precise duplicate of claim 2 with 3572
the addition of the words "and then subjecting the liquid outflow to a aerating operation."

The combination of aeration with the liquefying tank is common to the art, and appears in all of Waring's tanks and those of his imitators in that the sewage, after having been secluded in the liquefying tank is emptied therefrom through a non- 3573
disturbing outlet over a weir into a flush-tank. The effluent is further aerated by the air drawn into the flush tank siphon and is further aerated in the case of intermittent filtration as a third stage of sewage disposal.

Aeration is also a necessary accompaniment of
the Mueller patent and the Mouras patent when 3574
the effluent is further filtered as was the case at Logelbach. The history of the art shows that almost all tanks for plain sedimentation or liquefaction, or even chemical precipitation, were followed by aeration in various forms, either in simply flowing the sewage through an open channel or over

3575 a weir to the more complex arrangements by which it was sprayed or broken up in its descent by special contrivance. Mr. Scott-Moncrieff's cultivating filter U. S. patent 530,622, of 1894, and British patent No. 3312, of 1890, to Adney & Parry, also provided for aeration of the liquid effluent.

3576 Claim 4 reads as follows:

"The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow from light, air, and agitation until a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, then
3577 subjecting said pool under a non-disturbing inflow and outflow and under exclusion of light and air to the liquefying action of the so-cultivated micro-organisms until the solid organic matter contained in the flowing sewage is dissolved, then subjecting the liquid outflow to an aerating operation, and then to a filtering operation."

This claim reads the same word for word as
3578 claim 3 of the patent with the words added "and then to a filtering operation." As I understand the claim, it does not seem to me to describe anything novel to the art of sewage purification as it existed prior to the date of this patent. The combination of a liquefying tank with non-disturbing inflow and outflow secluded from light and air,
3579 the effluent from which was aerated and then filtered is found in nearly all of the installations of Waring in this country and described in his publications of 1876, 1888 and 1891.

It is found in the automatic scavenger of Mouras as installed at Logelbach, and as applied by Professor Pagliani in Italy. It is found in the tanks at

Medfield, Massachusetts, Altenheim and St. Joseph Hospital, Chicago, at Lawrenceville, New Jersey, and other places cited by me in the history of the art.

Claim 21 reads as follows:

"The process of liquefying the solid matter contained in sewage, which consists in secluding a pool of sewage having a non-disturbing inflow and outflow from light, air and agitation until a thick scum is formed on the surface thereof and a mass of micro-organisms has been developed of a character and quantity sufficient to liquefy the solid matter of the flowing sewage, the inflow serving to sustain the micro-organisms, and then subjecting said pool under the cover of said scum and under a non-disturbing inflow and outflow to the liquefying action of the so-cultivated micro-organisms until the solid matter contained in the flowing sewage is dissolved." 3581 3582

This claim is the same word for word as claim 2 of the patent, with the exception that in the 5th line of claim 21 after the word "until" the following words are added: "a thick scum is formed on the surface thereof and," while in claim 2 these words are not used. 3583

I do not find anything novel in the combination of a thick scum upon a liquefying tank. Such a scum is the necessary accompaniment of the conditions of bringing the sewage to a rest in a closed tank with non-disturbing inflow and outflow and 3584 subjected to the exclusion of light and air. Under such conditions the solids in the sewage which have a greater specific gravity than the liquid drop to the bottom of the tank, while those that have a less specific gravity than the liquid rise to the top and are there detained by the non-disturbing outflow from leaving the tank. Under such circumstances they form the thick scum mentioned in the claim which varies more or less in accordance with the amount of solids in the tank. Such scum is specifically mentioned by Dr. Alexander Mueller in his patent and by Professor Pagliani.

3586 Claim 7 of the patent reads:

"In an apparatus for the purification of sewage the combination of a septic tank and an outlet therefor disposed above tne bottom and below the normal water-level thereof, said outlet comprising a conduit having a longitudinal slot open across the greater part of the width of the tank."

Claim 7 does not seem to me to disclose any
3587 novel appliance, but such as has been common to settling tanks, sedimentation tanks, and liquefying tanks heretofore cited. In this connection I would specifically cite the Cheltenham tanks described on page 32 of Mr. Austin's report, one of the exhibits in this case, British patent No. 2329, of 1864 to Thomas Walker and another heretofore cited,
3588 British patent No. 3562, of 1868, to Thomas Smith and another, heretofore cited, British patent No. 2760 of 1871, to James B. Pow, British patent No. 7134 to Wilhelm Gurtler, in 1887, U. S. patent No. 505,166, of 1893, to Oluf E. Meyer, U. S. patent No. 580,793, of April 13, 1887, to G. D. Mitchell. These patents all show to a greater or less extent an open-
3589 ing extending across the greater part of the width of the tank, and insofar as such opening admits the outflow of the sewage at middepth the particular device here described, speaking broadly, does not seem to possess novelty.

If, however, it is intended to specifically confine said outlet to a conduit, as seems to be the case, such precise interpretation as may be given to this claim may be considered to be novel, although it is difficult to see wherein the improvement consists over the prior method.

Claim 8 reads:

"In an apparatus for the purification of sewage the combination of a septic tank having an outlet consisting of a pipe extending across the greater part of the width of the tank and disposed above the bottom and below the normal water-level thereof, said pipe having an opening in its wall throughout its length for admitting the effluent." 3591

This claim is like claim 7, but provides that the outlet conduit shall be a pipe disposed above the bottom and below the normal water-level of the tank, said pipe having an opening throughout its length. 3592

If this claim is to be construed broadly, the same citations which I have used in case of claim 7 will apply here. If, however, it is to be construed as a specific and exact appliance it may be possessed of some elements of novelty, as I can find nothing in the prior state of the art exactly conforming to the description in this claim. I apprehend, however, that the construction of the tank in this suit, as I understand it, does not answer to this specific description. 3593

Claim 5 reads as follows: 3594

"In an apparatus for the purification of sewage, the combination of a septic tank having an outlet disposed above the bottom and below the normal water-level of the tank, and open across the greater part of the width thereof, and an aerator connected with said outlet."

This claim calls for an outlet disposed above the

3595

bottom and below the normal water-level of the tank, open across the greater part of the width thereof, and an aerator connected with said outlet. As I understand this claim, it does not present anything new or novel in the art. The tanks of Colonel Waring and his imitators had a submerged inlet
3596 extending across the width of the tank which was formed by means of a baffle wall across the tank extending from a point above the surface of the liquid to some distance below the surface thereof, and the liquid passing below this wall the full width of the tank, passed then upward and outward through the outlet and was aerated by then
3597 falling into the flush tank.

British patent No. 2760 of 1871 to James B. Pow, provides for an outlet disposed above the bottom and below the normal water-level of the tank and open across the greater part of the width thereof, and an aerator connected with said outlet through which the effluent passes over a weir where it is aer-
3598 ated in the form of spray by three successive falls of the effluent accomplished by special device.

U. S. patent No. 505,166, 1893, to Oluf E. Meyer comprises an outlet similar to that described in claim 5.

Claim 6 reads as follows:

"In an apparatus for purifying sewage, the
3599 combination of a drain or sewer, a settling tank, connected therewith and adapted to receive the contents thereof, a septic tank connected with said settling tank and provided with an outlet disposed above the bottom and below the normal water-level of the tank and open across the greater part of the width thereof."

Claim 6 calls for the combination of a drain or sewer, a settling tank connected therewith, and a septic tank connected with said settling tank with non-disturbing outlet.

The arrangement of a catch-pit receiving a liquefying tank is not new in the art of sewage purification. Good illustrations of the use of catch-pits or settling tanks are afforded in British patent No. 3601
2329 of 1864 to Thomas Walker and another and U. S. patent 108,664, to Wigner. The Mouras U. S. patent 268,120, contains a grit or settling chamber in combination with a septic tank having an outlet disposed above the bottom and below the level of the tank. This outlet, however, is not open across the greater part of the width of the tank. 3602

Claim 11 of the patent reads as follows:

"In an apparatus for purifying sewage, the combination of a septic tank, an inlet disposed above the bottom of the tank and below the normal water-level thereof and occupying the greater part of the width of said tank, and an outlet extending across the greater part of the width of the tank and disposed above the bottom 3603
of the tank and below the normal water-level thereof."

Claim 11 is similar to Claim 5, leaving out aeration, but adding the feature of a wide non-disturbing inlet. Such an arrangement is old in the art, and I may cite the Clifton Union Works, described by Mr. Henry Austin's report. British patent, 3604
2329, 1864, to Thomas Walker and another, describes a tank provided with an inlet disposed above the bottom of the tank and below the normal water-level thereof, said inlet consisting of a sewer or delivery conduit disposed on the outside of the tank, and having several openings through the

3605

wall of said tank, said openings being below the top and above the bottom thereof.

Also I would cite British patent, 3562 of 1868, to Thomas Smith and another, also British patent, No. 364 of 1870, to George W. Wigner; also U. S. patent, No. 184,009, of 1876, to George R. Moore;
3606 also U.S. patent, 505,166,1893, to Oluf E. Meyer.

Claim 12 reads as follows:

"In an apparatus for purifying sewage, the combination of a septic tank, an inlet occupying the greater part of the width of said tank, and an outlet extending across the greater part of the width of the tank and disposed above the bottom of the tank and below the normal water-
3607 level thereof, said outlet comprising a pipe having a longitudinal slot therein extending the greater part of its length."

Claim 12 is similar to claim 11 except that the outlet which is disposed above the bottom of the tank and below the normal water level thereof, consists of a pipe having a longitudinal slot extending the greater part of its length. If this claim be con-
3608 strued broadly it would appear to be anticipated by most of the citations I have made on the part of claim 11, and is not a new or novel contrivance. If it be confined strictly to the description of a pipe with a longitudinal slot it may have elements of novelty, as I do not find anything in the art prior being specifically of this character.

3609 Claim 20 read as follows:

"In an apparatus for the purification of sewage, the combination of a septic tank, means for excluding air and light, a non-disturbing inlet for said tank disposed below the normal water-level thereof and provided with a broadened mouth, a non-disturbing outlet for said tank disposed below the normal water-level thereof and provided with a broadened mouth. and a sewage-conduit connected with said inlet."

This claim appears to cover a non-disturbing inlet with branches or broadened mouths, said inlet and outlet being below the top of the level of the tank, annd means for excluding light and air.

All of these features of liquefying tank are found 3611
in the art, are found in Colonel Waring's publications and the tanks built by his followers, and are common to the tanks at Clifton Union as described by Henry Austin, British patent No. 2329, of 1864, to Thomas Walker, British patent No. 364 of 1870 to George W. Wigner, U. S. patent 530,622, to Scott Moncrief (which latter has a non-disturbing sub- 3612
merged inlet with broadened mouth), British patent No. 7134 to Wilhelm Gurtler, and U. S. patent No. 505,166 to O. E. Meyer. This form of inlet and outlet with means for excluding light and air is found in Prof. Talbot's tank at Champaign, and in Mr. MacHarg's tanks at Altenheim and St. Joseph's Hospital.

3613

Claim 22 of the patent reads as follows:

"In an apparatus for the purification of sewage, the combination of a septic tank, means for excluding air and light, a non-disturbing inlet for said tank disposed below the normal water-level thereof, a non-disturbing outlet for said tank disposed below the normal water-level thereof, and a sewage-conduit connected with 3614
said inlet."

As I understand this claim, it has been anticipated by the patent of Mr. Alexander Mueller, by the automatic scavenger of Louis Mouras as described in his French, English and United States patents, by installations made by Professor Pag-

liani in Italy, by publications of Colonel George E. Waring, in 1876, 1884 and 1901, by the publications of Edward Phillbrick, the Engineering News, and of William Paul Gerhard, in his publication of 1890, by Frank L. Union in his U. S. patent 424,-838, by Mr. Scott Moncrief, in his U. S. patent 530,-
3616 622, and by the tanks at Altenheim and St. Joseph's Hospital in Chicago, in 1884 and 1889, and by the many installations made by the imitators of Colonel Waring in this country.

Q. 8. Have you heard or read the depositions of William S. MacHarg and Henry W. Hill, heretofore taken herein, and do you understand the con-
3617 struction and operation of the sewage tanks at the Altenheim, so-called, and the St. Joseph's Orphan Asylum, both at or near Chicago, described therein? A. I have and do.

Q. 9. Please state wherein the construction and operation of the sewage tanks at the Altenheim and St. Joseph's Hospital, as described in said deposi-
3618 tions of William S. MacHarg and Henry W. Hill, are similar to or different from the construction and operation of the sewage tank described in the Cameron patent No. 634,423, sued on in this cause, limiting your answer to claims 1 to 8 inclusive, 11 and 12 inclusive, and 20 to 22 inclusive? A. I find in the description of Mr. MacHarg in his testi-
3619 mony in this case and in the exhibits introduced by him that the tanks and purification plants at St. Joseph Orphan Asylum and Altenheim consist of a tank which subjects the sewage under the exclusion of light and air and agitation to the action of anaerobic bacteria. This is effected in the first compartment of the tank and partially in the sec-

ond compartment of said tank as shown in the exhibits of the St. Joseph Orphan Asylum.

The sewage being pumped out from the second compartment into a wooden cistern is then subjected to light and air; therefore the first claim of the patent appears to me to be completely covered 3621
in these two tanks.

I find that the second claim of the patent is fully covered by these tanks in that the sewage has a comparatively non-disturbing inflow and outflow, and is free from agitation. I have before pointed out that "non-disturbing inflow" is a relative term —that practically no liquid can be emptied into a 3622
vessel without some disturbance. The inflow into the tank at St. Joseph Hospital is made through a pipe at the level of the liquid in the tank, which is so small in proportion that it is practically non-disturbing. The outflow from the tank is made over the top of a baffle wall, protected by another baffle wall in such a manner that it also is non-disturbing. The tank is practically light and air 3623
tight and the inflow serves to sustain the micro-organisms.

I find that claim 3, being practically similar to claim 2, is also fully covered by the tanks in question. The added feature in claim 3 that the liquid outflow shall be subjected to a aerating operation is 3624
met by the fact that the sewage is lifted from the receiving chamber below the ground into a wooden cistern above the ground.

I find that claim 4 of the patent is fully met by these tanks in that to the process heretofore described there is added a filtering operation, which

3625 in this case was by intermittent filtration upon a plot of suitably prepared ground.

I find that claim 5 is fully met by this said tank in that it has the combination of a septic tank with an outlet disposed above the bottom and below the normal water-level of the tank and open across the
3626 greater part of the width thereof. This is accomplished by the two baffle walls heretofore referred to by means of which the sewage flows out from the septic tank and into the receiving chamber. The condition imposing aeration in claim 5 is met by the fact that the sewage in passing over the baffle wall drops some distance in the air into the receiving
3627 chamber at such times as the sewage level in the receiving chamber is below the baffle wall. In the event of the sewage in the receiving chamber being above the baffle wall aeration is obtained by the emptying of the liquid into the surface tank heretofore described.

I find that claim 6 is not anticipated by the tanks
3628 at St. Joseph Orphan Asylum and Altenheim in that they do not consist of the combination of a drain or sewer with a settling tank which is in turn connected with the septic tank. There is no grit chamber or preliminary settling tank at St. Joseph Orphan Asylum or at Altenheim, but the drain or sewer enters into the septic tank direct.

3629 I do not find any anticipaton of claim 7 in the St. Joseph Orphan Asylum or Altenheim tanks, as the outlets to said tanks do not comprise a conduit having a longitudinal slot open across the greater part of the width of the tank, unless by broad construction the space between the two baffle walls at the outlet might be so interpreted.

 3630

I do not find any anticipation of claim 8 in these tanks, there being no outlet consisting of a pipe extending across the greater part of the width of the tank and disposed as described in the claim.

I do not find any anticipation of these tanks of claim 11, except as to the outlet, which is anticipated, these tanks having an outlet extending across 3631
the greater part of the width of the tank and below the normal water-level thereof.

I do not find any anticipation of claim 12 in these tanks.

In claim 20 I find that there is no inlet in these tanks as described in the claim, with a broadened mouth, or disposed below the normal water-level, 3632
but I do find that the other parts of claim 20 are anticipated in these tanks.

I find claim 21 to be fully anticipated by these tanks, for reasons that I have already fully expressed in reference to earlier claims.

I also find claim 22 to be fully anticipated except as to the inlet of said tanks being disposed below 3633
the normal water-level thereof, all for reasons which I have fully explained in connection with other earlier claims.

Q. 10. Have you heard or read the depositions of Arthur N. Talbot and John C. F. Sell, heretofore taken herein, and do you understand the construction and operation of the sewage tanks at Ur- 3634
bana and Champaign, Illinois, described therein? A. I have and do.

Q. 11. Please state wherein the construction and operation of the sewage tanks at Urbana and Champaign, as described in said depositions of Arthur N. Talbot and John C. F. Sell, are similar

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to or different from the construction and operation of the sewage tank described in the Cameron patent No. 634,423, sued on in this cause, limiting your answer to claims 1 to 8 inclusive, 11 and 12 inclusive, and 20 to 22 inclusive? A. Taking up the Urbana tank, as described by Professor Talbot and
3636 shown on the plan which he submitted as an exhibit, I find the first claim of the patent is anticipated in this tank. I find that the second claim is anticipated insofar as the non-disturbing inflow and outflow are concerned if the baffle boards across the inlet end of the tank be taken as in place, and the weir across the outlet end of the tank be con-
3637 strued as a non-disturbing outlet. This weir passes completely across the width of the tank, and would, in my opinion, form a non-disturbing outlet.

I find the third claim fully anticipated by this tank.

I find the fourth claim fully anticipated by this tank with the exception that there is no filtering
3638 operation following the aeration of the effluent.

I find that the fifth claim is not fully anticipated in this tank, the outlet not being disposed above the bottom and below the normal water-level of the tank. The outlet, is, however, in my opinion, a non-disturbing outlet, with an aerator connected, and is open across the entire width of the tank.

3639 I find the sixth claim is not anticipated in this tank, there being no preliminary settling tank or grit chamber interposed between the sewer and the septic tank proper.

I find the 7th claim of the patent is not anticipated in this tank, the outlet not being below the normal water-level thereof.

 3640

I find the 8th claim is not anticipated in this tank, there being no outlet pipe having an opening in its wall throughout its length for admitting the effluent. It should be noted, however, in this connection, that the weir extending the full width of the tank at the outlet performs substantially the same duty as such a slotted pipe 3641
with the exception that it is placed so that the outlet is at the surface of the liquid instead of below.

I find that the 11th claim of the patent is anticipated in this tank with the exception that the outlet is not below the normal water-level of the tank. 3642

I find the 12th claim is not anticipated in this tank in that the outlet does not comprise a pipe having a longitudinal slot therein and disposed below the normal water-level.

I find the 20th claim is anticipated by this tank with the exception that the outlet for said tank is not disposed below the normal water-level 3643
thereof.

I find the 21st claim is anticipated by this tank in full.

I find the 22nd claim is anticipated by this tank with the exception that the outlet of same is not disposed below the normal water-level thereof.

3644 Taking the first Champaign tank and comparing it with the claims in the patent, I find that claim one is fully anticipated by such tank.

I find that claim 2 is also fully anticipated by such tank.

I find that claim 3 is also fully anticipated by such tank, the additional aeration and opera-

3645 tion being, in my opinion, accomplished by the flow over the outlet weir into the stream.

I find the 4th claim of the patent to be anticipated by this tank with the exception that no filtering operation followed the aeration of the effluent.

3646 I find the 5th claim of the patent to be anticipated by this tank if it be understood from Professor Talbot's description that the baffle boards which he described as being spaced regularly across the tank were so situated that one of them was near the outlet end of the tank, as it is reasonable to believe that it was.

3647 I do not find that the 6th claim is anticipated by this tank.

I do not find that the 7th claim is anticipated by this tank unless it can be construed very broadly that the space between the last baffle board and the outlet weir and extending clear across the tank would comprise a conduit having
3648 a longitudinal slot open across the greater part of the width of the tank.

I do not find that the 8th claim is anticipated in this tank.

I find that the 11th claim is anticipated in this tank on the assumption that the baffle boards were spaced reasonably near the outlet and inlet
3649 of said tank.

I do not find that the 12th claim is anticipated by this tank.

I find that the 20th claim is fully anticipated by this tank.

I find that the 21st claim is fully anticipated by this tank.

I find that the 22nd claim is anticipated by this tank on the same assumption which I made in the case of the 12th claim.

Taking the second Champaign tank as described by Professor Talbot and as shown by the plan submitted by him as one of the exhibits in this case, I find that the first claim is anticipated 3651
by this tank.

I find that the second claim is anticipated by this tank.

I find that the third claim is anticipated by this tank.

I find that the 4th claim is anticipated by this tank, with the exception that no filtering opera- 3652
tion follows the aeration of the effluent.

I find that the 5th claim is anticipated by this tank if by outlet can be construed the space between the baffle board and the weir over which the effluent flows. This space is somewhat greater in this tank than is usually the practice, both for the inlet and outlet. Nevertheless 3653
the baffle boards at the inlet and outlet end would operate to produce a non-disturbing inflow and outflow.

I do not find that the 6th claim is anticipated by this claim.

I do not find that the 7th claim is anticipated 3654
by this tank.

I do not find that the 8th claim is anticipated by this tank.

I find that the 11th claim is anticipated in this tank if the same broad construction is used which I have indicated in considering claim 5.

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I do not find that the 12th claim is anticipated in this tank.

I find that the 20th claim is anticipated in this tank with the same construction as given to claim 5.

I find that the 21st claim is fully anticipated by
3656 this tank.

I find that the 22nd claim is anticipated by that tank if the broad construction which I have indicated in claim 5 is taken.

Q. 12. Mr. Henry W. Hill informs me that,
having visited Peru since his deposition in this
cause was taken, he finds from personal exami-
3657 nation that he was mistaken in his description of
the sewage tank at St. Bede's College, and be-
cause of this I have had a draftsman examine
said tank and make a drawing thereof under Mr.
Hill's direction. As explained by Mr. Hill and
as shown in this drawing, that sewage tank is not
constructed of wood but of brick masonry. As-
3658 suming this tank to be cylindrical in form, con-
structed of brick masonry, nine feet and six
inches in diameter, and ten feet deep, the cylin-
der being set on end; and assuming that the top
was covered and the inlet and outlets, water-
level and other details as shown in the drawing
now before you, marked "Defendants' Exhibit
3659 Sewage Tank at St. Bede's College, Peru, Illi-
nois," please state wherein its construction and
operation is similar to or different from the con-
struction and operation of the sewage tank de-
scribed in the Cameron patent, No. 634,423, sued
on in this cause, limiting your answer to claims
1 to 8 inclusive, 11 and 12 inclusive, and 20 to

22 inclusive. A. I find from the drawing that the tank referred to is nine feet six inches in diameter and that the water level is shown to be five feet six inches above the bottom, leaving four feet six inches from the water level from the top of the tank to the surface of the ground. The
tank is circular in plan and the inlet pipe enters 3661
at one side with its invert six inches above the level of the water as shown. On the opposite side from the inlet is the outlet box twelve inches square shown with its bottom at about the level of the liquid. A masonry baffle wall extending across the tank in front of the outlet has a depth
of fourteen inches below the liquid contents as 3662
shown, and is enclosed at the top so that the only entrance to the outlet is beneath the surface of the liquid.

On comparing this tank with the claims of the Cameron patent, I would express it as my opinion that claim 1 is anticipated by this tank with
the exception that there is nothing to show 3663
whether the effluent is exposed to the light. Aeration would, in my opinion, be obtained in the outlet box.

Claim 2 is anticipated by this tank with the exception that the inlet to the tank is not fully non-disturbing, being located some distance
above the liquid. I might observe that the ques- 3664
tion of disturbance in this cause is a question of the relative volume of inflow to the quantity of sewage remaining in the tank. In my opinion it is no detriment to this tank that the inlet is not completely non-disturbing, it being more important that the outlet be non-disturbing than that the inlet should be so.

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I find that claim 3 of the patent is anticipated by this tank with the exception of the non-disturbing inflow as noted in reference to claim 2, the aeration being obtained in the outlet box.

I find that claim 4 of the patent is anticipated by this tank with the same exception as to in-
3666 flow and with the further exception that I understand no filtering operation completes the process.

I find that claim 5 of the patent is fully anticipated by this tank.

I find that claim 6 of the patent is not anticipated by this tank.

3667 I find that claim 7 is anticipated by this tank if a broad construction should be placed upon the description of an outlet comprising a conduit having a longitudinal slot open across the greater part of the width of the tank. A very strict construction of this language would not, in my opinion, show an anticipation.

3668 I find that claim 8 of the patent is not anticipated by this tank.

I find that claim 11 of the patent is anticipated by this tank with the exception of the inlet, which is not disposed above the bottom of the tank and below the normal water-level thereof, and does not occupy the greater part of the width
3669 of said tank.

I do not find that claim 12 of the patent is anticipated by this tank.

I find that claim 20 is anticipated by this tank so far as regards the outlet, but not as regards the inlet.

I find that claim 21 is anticipated by this tank

 3670

with the exception of the inlet being non-disturbing in the sense that it is located below the liquid contents. In my opinion the location and arrangement of the outlet is such that a scum will form over the surface of the tank which would of itself serve to exclude light and air if there were no other cover. 3671

I find that claim 22 is anticipated by this tank with the exception that the inlet is not disposed below the normal water-level thereof.

Q. 13. Please take up and consider such of the prior sewage tanks described in the deposition of F. Herbert Snow heretofore taken herein, as you consider material, and state wherein their 3672
construction and operation are similar to or different from the construction and operation of the sewage tank described in the Cameron patent No. 634,423, sued on in this cause, limiting your answer to claims 1 to 8 inclusive, 11 and 12 inclusive, and 20 to 22 inclusive. A. I will confine my answer to four or five installations made 3673
prior to the date of this patent mentioned by Mr. Snow, and located in the eastern States, which I consider typical of the practice generally prevailing.

I will first compare the sewage plant at Lawrenceville School for Boys, which is described in a book entitled "Sewage Disposal in the 3674
United States," by Rafter & Baker, page 511.

I find that claim 1 of the patent is fully anticipated by the Lawrenceville tank, the sewage being first received into a long compartment from which it is emptied at its further end into a second compartment by means of an elbow pipe

with the mouth turned down below the level of the liquid at the outlet, thence into a third compartment through a similar elbow pipe similarly arranged, and at the end of the third compartment over a weir where it receives aeration. The sewage is then pumped to the filter field, where
3676 it receives both light, aeration and filtration.

I find that claim 2 of the patent is fully anticipated by this tank.

I find that claim 3 is fully anticipated in this tank.

I find that claim 4 is fully anticipated in this tank.

3677 I find that claim 5 is anticipated in this plant with the exception that the outlet is not open across the greater part of the width of the tank, but is in this case an elbow pipe with the mouth turned downward.

I find that claim 6 is fully anticipated in this plant, there being a preliminary settling tank or
3678 grit chamber connected with the septic tank and sewer.

I do not find that Claim 7 of the patent is anticipated in this plant.

I do not find that Claim 8 is anticipated in this plant.

3679 I find that Claim 11 is anticipated in this tank with the exception that the inlet does not occupy the greater part of the width of said tank, and that the outlet is not disposed above the bottom of the tank and below the normal water-level thereof unless the final compartment could be considered in its entirety as an outlet.

I do not find that Claim 12 is anticipated in this plant.

I find that Claim 20 is anticipated in this tank with the exception that the inlet and outlet are not provided with a broadened mouth.

I find that Claim 21 is fully anticipated by this
tank, which is covered and so arranged that a scum 3681
would necessarily form upon its surface.

I find that Claim 22 has been anticipated by this tank, with the exception that the inlet and outlet are not disposed below the normal water-level of the tank.

I will next take up the sewage purification plant
at Worcester, Massachusetts, and compare that 3682
with the patent.

The sewage at Worcester at first passes into a small gate chamber from which it is conducted into a liquefying tank, about thirty feet long, sixteen feet wide, and covered with arches. The sewage enters the tank by a pipe whose mouth is turned down
so as to deliver the liquid below the level of the out- 3683
let. About two-thirds the distance from the inlet to the outlet a brick partition is built across the tank in which are placed four plates of brass perforated with sixty holes, one-quarter of an inch in diameter. The sewage is received into the larger end of the tank where the solids are contained, the
fluid part on straining through the brass plates into 3684
the smaller division. The outlet from the smaller division consists of an elbow pipe so turned down that it receives the liquid at mid-depth of the tank. The effluent is then led to a filtration field where it is aerated, subjected to the action of air and light and filtered.

3685 I find that Claim 1 in the patent is fully anticipated by this plant.

I find that Claim 2 is also fully anticipated by this plant.

I find that Claim 3 is also fully anticipated by this plant.

3686 I find that Claim 4 is also fully anticipated by this plant.

I find that Claim 5 is anticipated by this plant with the exception that the outlet is not open across the greater part of the width of the tank.

I find that Claim 6 is not anticipated in this plant.

3687 I find that Claim 7 is not anticipated in this plant.

I find that Claim 11 is anticipated in this plant with the exception that the outlet does not extend across the greater part of the width of the tank.

I find that Claim 12 is not anticipated in this tank.

3688 I find that Claim 20 is anticipated in this plant, with the exception that the inlet and outlet are not provided with a broadened mouth.

I find that Claim 21 is fully anticipated in this plant.

I find that Claim 22 is fully anticipated in this plant.

3689 I will next take up the sewage purification plant at Medfield, Massachusetts. The sewage at Medfield is received into two tanks divided by two cross walls into three compartments each. The inlet is so disposed that the sewage is delivered into the first compartment at the level of the outlet, passes over the first cross wall into the second compart-

ment and from the second compartment over a cross wall into the third compartment where a baffle wall diverts it downward to below an excelsior strainer through which it passes upward to the outlet. It is then led into a second tank with an outlet at mid-depth from which it is led to the filter field where it is subjected to the action of 3691
light and air and first aerated and then filtered.

I find the first claim of the patent is fully anticipated in this plant.

I find the second claim of this patent is fully anticipated in this tank in that the central compartment of each tank between the two cross walls has a non-disturbing inflow and outflow as also does 3692
that portion of the third compartment below the excelsior screen.

I find that Claim 3 is anticipated in this plant, under the same interpretation used for Claim 2.

I find that Claim 4 is anticipated in the same way.

I find that Claim 5 is not anticipated in this 3693
plant , unless a broad construction can be placed upon the arrangement of the final screen and baffle board.

I find that Claim 6 is not anticipated in this plant.

I find that Claim 7 is not anticipated in this 3694
plant, unless the broad construction suggested for Claim 5 could be adopted.

I find that Claim 8 is not anticipated in this plant.

I find that Claim 11 is not anticipated in this plant, unless it can be construed that the central

3695 compartment is the liquefying tank proper, and the inlet to it is over the cross baffle wall.

I find that Claim 12 is not anticipated in this plant.

I find that Claim 20 is not anticipated in this plant, unless a broad construction could be given
3696 to the baffle wall in the central chamber.

I find that Claim 21 is anticipated in this tank.

I find that Claim 22 is not anticipated in this tank, except upon broad construction as heretofore mentioned.

I will next take up the sewage purification plant at the Massachusetts Reformatory at Concord, as
3697 described in Rafter & Baker's book, page 468.

The sewage in this case passes into two duplicate liquefying tanks of masonry arched over, and about 12 feet square, from which, when filled to a depth of five feet, the liquid overflows from its mid-depth to an unseen siphon into a second receiving chamber. From here it is led to a filtration field where
3698 it is aerated and filtered.

I find that Claim 1 is fully anticipated in this plant.

I find that Claim 2 is fully anticipated in this plant.

I find that Claim 3 is also fully anticipated in this plant.

3699 I find that Claim 4 is also fully anticipated in this plant.

I find that Claim 5 is anticipated in this plant, except that the outlet is not open across the greater part of the width of the tank.

I find that Claim 6 is not anticipated in this plant.

I find that Claim 7 is not anticipated in this plant.

I find that Claim 8 is not anticipated in this plant.

I find that Claim 11 is anticipated in this plant, with the exception that the outlet does not extend across the greater part of the width of the tank. 3701

I find that Claim 12 is not anticipated in this plant.

I find that Claim 20 is anticipated in this plant, with the exception that the inlet and outlet are not provided with a broadened mouth.

I find that Claim 21 is fully anticipated in this plant. 3702

I find that Claim 22 is also fully anticipated by this plant.

Q. 14. Please answer the same question with reference to the testimony of Mr. Benezette Williams heretofore given in this cause? A. I will take for an example of the Waring type of liquefying tank and filter the description in page 24 of the Flush-Tank Company's catalogue, which is an exhibit in 3703
this case, together with the accompanying cut. This cut shows that the inlet to the liquefying tank is an elbow pipe so turned as to deliver the inflow at a point below the normal level of the outlet. A cross wall is built in the tank between the inflow and the outflow. The outflow pipe is also an elbow pipe 3704
similarly arranged to that of the inflow pipe and serves to deliver the contents of the tank at mid-depth into the flush tank. In this operation it becomes aerated by means of the air in the flush tank from which it is delivered to the irrigation field where it is further filtered.

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As these tanks are often built it will be found that in place of the elbow pipe in the liquefying tank, a cross wall of masonry extending below the normal surface of the liquid is built so as to trap both the inlet and outlet pipe. A description of this variation is necessary to understand a com-
3706 parison with the claims of the patent, and the two arrangements will be alluded to as the trap wall and the elbow pipe arrangement respectively.

Referring now to the claims of the patent, I find that Claim 1 is anticipated by the Waring plant.

I find that Claim 2 is fully anticipated by the Waring plant.

3707 I find that Claim 3 is fully anticipated by the Waring plant.

I find that Claim 4 is fully anticipated by the Waring plant.

I find that Claim 5 is anticipated by the Waring plant, when built with the trap wall.

I find that Claim 6 is not anticipated by the
3708 Waring plant.

I find that Claim 7 is anticipated in the Waring plant, built with a trap wall if the space between such trap wall and the mainwall can be broadly designated a conduit, having a longitudinal slot open across the greater part of the width of the
3709 tank.

I find that Claim 8 is not anticipated in the Waring plant.

I find that Claim 11 is fully anticipated by the Waring plant, when built with a trap wall.

I find that Claim 12 is not anticipated in the Waring plant.

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I find that Claim 20 is anticipated by the Waring plant, when built with a trap wall.

I find that Claim 21 is fully anticipated by the Waring plant.

I find that Claim 22 is also fully anticipated by the Waring plant.

Q. 15. Disregarding details but keeping in mind 3711
the requirements of the Cameron patent No. 634,-
423, sued on in this cause, please enumerate the
prior patents, publications, and sewage disposal
tanks or plants referred to in the testimony in this
cause, which you consider to empoly, apply or carry
out the same process—that is, the process described
in said patent and particularly specified and claim- 3712
ed in its process claims? A. British patent No.
1706, to Beven G. Sloper, 1870; Dr. Alexander
Mueller in a published account in Landwirthschaf-
tliche; the Sanitary Draining of Houses and Towns,
published in 1876 by George E. Waring; the Insane
Asylum at Worcester, Massachusetts, built in 1876,
described by Rafter & Baker, page 456; U. S. patent 3713
184,099, to George R. Moore, 1876; German patent
No. 9792, to Dr. Alexander Mueller, 1878; Wo-
man's Prison, Massachusetts, 1879, installed by
Colonel Waring; Installation at Bryn Mawr Hotel,
Pennsylvania, 1881, by Colonel George E. Waring;
Engineering Record, September 1st, 1881, Descrip-
tion by Unknown Constant Reader of a Proposed 3714
Air-tight Cesspool; French patent 144,904, to Louis
Mouras, 1881; Description of Mouras automatic
scavenger in Cosmos le Mondes December, 1881,
page 622 and in 1882, page 97, and in 1883, page
110; British patent 5391 to William R. Lake, in
1881; this being Mouras' British patent. Descrip-

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tion of Mouras' automatic scavenger in the Minutes of the Proceedings of Civil Engineers of London for 1882, Volume 48, page 350; Description of Mouras' automatic scavenger in the Engineering News of New York City April 15, 1882; Installation by Benezette Williams of a plant at Blair Lodge,
3716 1882; Installation at Lawrenceville, New Jersey, School for Boys, 1882; Paper by Robert Warrington, in England, before the Society of Arts, Volume 30, page 532, entitled "Some practical Aspects of Recent Investigations on Nitrification," 1882; Installation of a plant at Massachusetts Reformatory, Concord, 1883; Sanitary Engineer, of May 10,
3717 1883; Article by Edward S. Phillbrick; Sanitary Record, Volume 8, page 444, 1883; Letter from Edward S. Phillbrick, suggesting sewage plant for hospital; Installation of the Mouras automatic scavenger at Logelbach at the words of Mr. Herzog, described in the proceedings of the Institute of Civil Engineers, Volume 78, page 532, for 1883; U.
3718 S. patent 280,545, July 3, 1883 to Silas Wilcox; Description of Mouras automatic scavenger by E. Thurry, in the Annaels Industrielles August 24, 1884, page 253; also translation in the miutes of the proceedings of Institute of Civil Engineers, Volume 78, page 502; Installation at Altenheim, Chicago, by W. S. MacHarg, 1884; Installation at
3719 Sagamore Hotel, Green Island, Lake George, by Rudolph Hering, 1885; Installation at Medfield, Massachusetts, in 1887; Publication of book entitled "Sewage and Land Drainage," by Colonel George E. Waring, 1888; Installation at St. Joseph Orphan Asylum, by W. S. MacHarg, 1889; Publication of book, entitled "Household Wastes" by William

Paul Gerhard, 1890; British patent 3312 to Adney & Parry, 1890; U. S. patent 424,838 to Frank L. Union, 1890; Publication by Professor Pagliani, International Congress of Hygiene, 1891; Publication by Flush-Tank Company, Chicago, 1892; Report on Scott Moncrief's Process at Ashted, 1893;
Publication by George E. Waring of book entitled 3721
"Modern Methods of Sewage Disposal," 1894; U. S. patent 530,622, December 11, 1894, to W. D. Scott Moncrief; Installation of Urbana Tank, at Urbana, Illinois, 1894; Installation of First Champaign Tank, Champaign, Illinois, 1895; Installation at St. Bede's College, Peru, Illinois, 1891.

Q. 16. Please assume that in use the apparatus 3722
and process of the Cameron patent No. 634,423, sued on in this cause, have two special features or characteristics, as follows: (1) The sewage is allowed to "remain in the tank for a considerable period of time in order that the bacteria of putrefaction may manifest their destructive activity, and
so accomplish their work of decomposition and liq- 3723
uefaction;" and (2) "that the contents of the tank must either be practically shut off from all contact with the atmosphere, or the surface of the sewage must remain quiescent for a sufficient length of time to permit their accumulation of a thick scum on the top, which operates to ex-
clude the air and light;" and on 3724
this assumption please enumerate the prior patents, publications, and sewage disposal tanks or plants referred to in the testimony in this cause which you consider to possess and employ these same two special features or characteristics? A. The tanks and publications and plants referred to

in my previous answer would all come under the definition which you have given of septic action so-called, and in addition to such tanks, publications and plants which were intentionally designed for the reduction of solids by liquefying action, the answer would oblige me to list a large number of
3726 plants provided with tanks which in their time and day were called plain sedimentation tanks, but which were provided with non-disturbing inflow and outflow practically covered from light and air, so that the solids were retained in the tank a sufficient length of time for the liquefying action of anaerobic bacteria. Among the examples of such tanks
3727 as these are the tanks described by Henry Austin, in his report in 1852, the tanks I have described at the plant at Ealing, in England, at Aldershot Camp Farm; the plant at Wimbleton, England; at Chessick & Murton, in England; at Amherst, in Massachusetts, and other tanks of a similar nature. Action would also be observable in such tanks as built
3728 by Adney & Parry and such as are shown in U. S. patent 366,333; British patent 7134 of 1887; and others of a like nature.

Among the best examples, both of these and those mentioned in my previous answer are the tanks at Ealing, England, the Automatic Scavenger of Louis Mouras, in France, the installations mentioned by
3729 Professor Pagliani in Italy, the patent to Dr. Alexander Mueller, of Berlin; and in this country the publications of George E. Waring, Edward Phillbrick, William Paul Gerhard, and others, and the installations which I have specifically compared with the patent in the Eastern States and in Illinois, such as the tanks at Lawrenceville, New Jer-

sey, Worcester, Massachusetts, Medfield, Massachusetts, the Reformatory at Concord, and the tanks at Champaign and Urbana, St. Joseph Orphan Asylum and Altenheim, Chicago, and St. Bede's College, at Peru, Illinois.

Adjourned till Friday, Sept. 8, 1905, at 10 o'clock
A. M. 3731

Chicago, September 14, 1905; 10 o'clock A. M.; met pursuant to adjournment; present as before, with the addition of Mr. Livingston Gifford as counsel for complainant.

See entry in reference to meeting
September 8, at beginning of deposition 3732
of Charles B. Burdick, and entry in reference to adjournment to this date at end of second deposition of Henry W. Hill.

Q. 17. Since you were last on the stand the
deposition of Charles B. Burdick, Rev. Vincent
Huber and Henry W. Hill have been taken with 3733
special reference to the sewage tank at St. Bede's College, Peru, Illinois. Have you read such depositions and do you understand the same? A. I have and do.

Q. 18. Please state whether there is anything
in the construction or operation of that tank at
St. Bede's College, as described in the depositions 3734
referred to in my previous question, which requires any qualification of your views heretofore expressed in reference thereto, and particularly give your views in reference to the construction and operation of that tank as described in said depositions. A. It does not seem to me that

3735 the depositions of Mr. Burdick and Rev. Huber would modify in any way the opinion which I have already expressed as to the liquefying action which would go on within such tank.

The scum described by Rev. Huber apparently covered the entire area of the tank, with the
3736 exception of a small hole near the inlet about 18 inches in diameter. As the area of the tank is something over 71 or 72 square feet it is evident that the proportion of liquid not covered by scum to that which is so covered would be in the ratio of about one to seventy, and thus, in my opinion, no modification or disturbance of the liquefying
3737 action would normally take place.

As I have stated before, it is more important in tanks of this kind that there should be a non-disturbing outflow of the character shown in this tank than that there should be a non-disturbing inflow, especially in tanks where the inflow is relatively small to the contents of the tank.

3738 I further observe from the testimony of the Rev. Vincent Huber that the roof water was connected with this tank, and the testimony of Mr. Hill shows that the area of the roof so connected was a little over 18,700 square feet. The normal rainfall of one-quarter inch an hour would, therefore, cause about 2,500 gallons to flow into
3739 the tank, and as the tank has a liquid capacity of about 3,000 gallons, such rainfall would theoretically displace a considerable portion of the liquid contents. Practically, however, a large portion of the solid matters would still be retained in the tank because of the trapped outlet and the liquefaction would continue.

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The normal dry weather flow will probably closely correspond to the amount of water used in the institution, which is stated by Rev. Vincent Huber to be from 2,000 to 8,000 gallons per day, and as the liquid capacity of the tank is about 3,000 gallons, the sewage would theoretically have a period within the tank of something 3741
over one day's rest, the solids, however, being detained by the trapped outlet would of course be detained a much longer time than this, that is to say, until liquefied.

The testimony seems to disclose that the tank was originally covered with boards which have since rotted so as to leave a partial opening. It 3742
would appear to me that this would indicate a tank of sufficient tightness to meet the claims of the patent. Since the decay of the wooden cover has left a partial opening, it would appear to be demonstrated from the evidence that the surface scum was sufficient in quantity to produce liquefying action regardless of the cover. 3743

Cross-Examination by Mr. Gifford.

X. Q. 19. Of the structures that you have referred to as existing in the art prior to the Cameron patent in suit, which have you personally seen? A. I have seen the works at Croyden, in England, in the year 1888, also the Aldershot Camp Farm in England in the same year. In 3744
this country I saw the tank at Champaign, in about 1898, I should judge. Of the installations which I have mentioned as being designed along the lines suggested by Colonel George E. Waring, I can only now recall that at Bair Lodge, Lake Forest, Illinois, which I saw probably in

1896, and one at the residence of Byron L. Smith, Esq., of Lake Forest. These two are believed to have been installed by the Flush-Tank Company. Other tanks which I believe to be credited to the suggestions of Colonel Waring are one at the Catholic institution at Dubuque, Iowa,
3746 whose name I have now forgotten, but which I think was an orphan asylum. This I saw in the year 1898. Also one for the State Hospital for the Insane at Independence, Iowa, which I saw in the year 1901. These are all that I recall at this time.

In view of the last answer complainant's
3747 counsel objects to all the testimony of the witness Alvord touching any structures or processes that are not either referred to in the last answer as having been seen by him, or are represented by exhibits actually introduced in evidence in this case; the
3748 ground of this objection being that in the absence of any personal knowledge by the witness as to the same or any exhibits properly proven from the patents or publications in the prior state of the art, the statements of the witness touching the same are entirely
3749 incompetent and hearsay. The testimony of the witness as to the works at Croyden and Aldershot are objected to as incompetent on the ground that they represent uses in a foreign country.

XQ. 20. Please refer to the drawing of some exhibit or exhibits in this case showing the construction of the tank that you saw respectively at Blair Lodge, Lake Forest, Illinois, also at Smith's residence, Lake Forest, also at the Catholic Institution at Dubuque, Iowa. A. The installation at Blair Lodge and the residence of 3751 Byron L. Smith, Esq., both at Lake Forest, are substantially built as shown in the drawing on page 24 of the catalogue of the Flush-Tank Company for 1892, which has been heretofore submitted as an exhibit in this case.

I am not prepared to say that the installations mentioned follow the details of the drawing in 3752 every minute particular, but the general arrangement is remarkably like that shown in the catalogue which I have mentioned.

With reference to the installation at Dubuque, I have never seen a drawing.

XQ. 21. Have you in your testimony referred to two kinds of bacterial action upon the solid or- 3753 ganic matter of sewage; one being a nitrifying action produced by aerobic bacteria, and the other being a liquefying action produced by anaerobic bacteria? A. I have.

XQ. 22. When these two actions are applied respectively to fresh sewage, what is the nature of the effect that they produce upon the solid 3754 organic matter which is referred to respectively by the terms "nitrifying" and "liquefying." A. I think it will be observable that in my testimony I have nowhere drawn sharp distinction between the liquefying and the nitrifying action, and I am of the belief that such sharp distinctions cannot

3755

be warranted in the present state of the art. In
other words, if there is a difference between the
form of chemical action which goes on in the
presence of anaerobic bacteria and that which
goes on in the presence of aerobic bacteria the
line of demarcation is not so marked that we
3756 can say with truth where one begins and where
the other ends. In many instances it is possible
trat both are going on at the same time. There-
fore it is very difficult to say with absolute cer-
tainty that one form of effect is absolutely pro-
duced by liquefying action, so-called, and that
another form of effect is produced by nitrifying
3757 action.

Speaking very generally, it is the belief at the
present time that liquefying action proceeds un-
der conditions which are favorable to the produc-
tion of anaerobic bacteria, while nitrifying action
proceeds best under conditions which are favor-
able to the growth of aerobic bacteria.

3758 XQ. 23. What are those conditions respec-
tively and how do they differ from each other?
A. Speaking generally, it is believed at the pres-
ent time that anaerobic conditions are best pro-
duced by the relative absence of agitation, by
the presence the presence of some degree of heat,
such as is normally produced by the chemical
3759 action taking place in the sewage itself and to
some limited extent by the exclusion of light and
the absence of dissolved oxygen in the liquid.
With reference to the exclusion of light, how-
ever, and the absence of air(it is felt just at this
time that it has been demonstrated that these con-
ditions are not absolutely essential to the promo-
tion of liquefaction.,

 3760

The conditions which are now supposed to be favorable to nitrification are the presence of a sufficient amount of dissolved oxygen in the liquid, its passage through a medium which can be aerated at intervals, and upon which the cultivation of bacteria is supposed to take place, such a a sand filter.
It is, however, doubtful if the conditions which I 3761
have outlined for liquefaction are entirely inimicable to the life of aerobic bacteria, or if the conditions which I have outlined for nitrification would wholly preclude the existence of anaerobic bacteria.

XQ. 24. When nitrification by aerobic bacteria
occurrs in the solid organic matter of said sewage, 3762
what change from external appearance seems to take place in such solid organic matter? In other words, does the solid organic matter seem to disappear, and if so, what does it seem to turn into? A. So far as I have pursued the subject, I am not able to conceive of nitrification alone as taking place
in the solids of sewage, and thus far in my study of 3763
the subject I have come to a condition of mind where I am unwilling to accept a too detailed statement as to exactly what takes place in the resolving of the highly complex form which the wastes of human life assume to their simpler elements. This is because
I have observed that a good many ingenius 3764
theories which have from time to time been accepted, have been disproved. I am, therefore, of the opinion that it is not wise to attempt a too detailed explanation at the present time as to just what takes place in dissolving sewage, for the reason that I believe we are leaving safely proven facts for

interesting theory when we attempt to advance too far. As an illustration of this, I will only mention the generally accepted theory which was disseminated when the septic tank of Mr. Cameron was first described that the entire exclusion of light and air is necessary to the growth and propagation of
3766 anaerobic bacteria, a theory which I now believe is not generally thought to be true. As a further instance, I might mention that at one time it was thought that ritrification was due to a particular species of bacteria, and that particular species was supposed to have been isolated and studied. It it now, I think, pretty generally accepted that there
3767 are a great variety of bacteria which promote nitrification. Other instances might be mentioned of the rapidly changing views which have taken place upon certain portions of the study of sewage purification due, in my opinion, to a somewhat eager acceptance of a minute explanation of the process.

3768 The answer is objected to as irresponsive. The witness is requested particularly to confine his answer to the question as nearly as possible.

XQ. 25. I endeavored to frame my question so as to exclude theoretical considerations as much as possible by expressly referring in my question to such changes as seem to take place from external
3769 appearance. In the nitrification of sewage that has not been preliminarily treated to a liquefying anaerobic treatment, what effect does such nitrification from external appearances appear to produce upon the solid organic matter of the sewage? A. I am unable to say. I have never attempted to conceive of nitrification alone proceeding in the solids of sewage.

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XQ. 26. When sewage that has not been subjected to a preliminary liquefying anaerobic treatment is subjected to what you have referred to as nitrifying conditions what changes from external appearance seem to occur in the solid organic matter of the sewage? A. The solids seemed to be resolved from higher complex chemical forms to simpler 3771
complex chemical forms. In appearance they seem to dissolve and liquefy. This seems to be especially true of the solids which are caught on the surface of a sand filter. All sewage is undergoing chemical change, decay, dissolution, or decompositition, from the moment it is created,unless arrested by the action of excessive heat or antiseptic 3772
chemical.

XQ. 27. You say in your last answer, "In appearance they seem to dissolve and liquefy." Is this accompanied by the giving off of gas? A. Under some circumstances it is, as for instance, when an excessive amount of solids are accumulated in such a manner that bacterial growth is not promoted. 3773
Under other circumsances, such as the depositing of sewage upon an intermittent filtration field of adequate area, a little odor is generally experienced.

XQ. 28. In the printed pamphlet containing the report of yourself and Julian Griggs, dated May 1st, 1898, and entitled "A Report to the Director of Public Improvements of the City of Co- 3774
lumbus, Ohio, on the Proper Disposal of the Sewage of the City," are the following statements contained:

"Dilution consists in bringing the sewage into contact with a sufficient quantity of fresh water so that the dissolved oxygen which such water always contains can promote the bacterial action and subsequent nitrification.

. . . .

Putrefaction occurs inevitably when there is not enough dissolved oxygen in the water to promote the nitrifying process. Up to a certain point with an admixture of fresh water enough dissolved oxy-
3776 gen is available for the purpose, but when once exhausted the nitrifying process is retarded or altogether ceases and obnoxious gases are generated. There is, therefore, a definite limit or proportion of fresh water which must be properly mingled with the sewage in order to rapidly and efficiently purify it. Where this amount is available no more economical or rapid method of purification can be found. The amount of fresh water thus required
3777 cannot be stated in fixed terms with satisfaction."

A. They are.

XQ. 29. When the nitrifying conditions are supplied by the admixture of fresh water containing dissolved oxygen, have you ever observed what, from outward appearance, seems to happen to the organic solids of the sewage? A. They seem to dissolve, to decompose, or decay, or to be
3778 liquefied. And with sufficient proportions of fresh water this is accomplished without the production of offensive gases.

XQ. 30. In view of the fact that the solid organic matter of sewage seems to dissolve when subjected to nitrifying conditions without any
3779 preliminary anaerobic or septic treatment, why is it that such preliminary anaerobic or septic treatment is employed? In other words, why is it that the sewage is first subjected to the anaerobic or septic conditions and subsequently to the aerobic or nitrifying conditions? A. In my opinion, the solids of sewage, which is emptied into

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a sufficient quantity of fresh water, undergo anaerobic dissolution, that is to say, I do not believe that nitrifying conditions ever entirely eliminate liquefying conditions, and it is my idea that each solid particle becomes, as it were, a miniature septic tank of its own in which septic action, so-
called, or liquefying action under anaerobic condition, is set up and accomplishes the initial stage of dissolving the solids. 3781

This initial stage we seek to accelerate where sufficient flow of water is not present by retaining these solids in a liquid tank so that this dissolution may be accomplished as rapidly as possible. 3782

XQ. 31. Why is it that it is better to provide for the anaerobic or liquefying action under one set of conditions and to provide for the aerobic or nitrifying action under a separate and subsequent set of conditions, rather than to let both actions take place conjointly under the same set
of conditions? A. I believe it to be largely a 3783
question of expediency, and to my mind the presence of a large body of water sufficient for the purpose determines this expediency. As I have before said, I believe anaerobic bacteria exist freely where conditions cause aerobic bacteria to preponderate; also I believe the converse of this
proposition is true. Therefore, liquefying action 3784
will often proceed in sufficient amount in the solids of sewage where the conditions are evidently favorable to aerobic life. This is the case of the fresh water, and also the filter beds. I am further of the opinion that a sufficient amount of liquid assists bacterial action by promoting mo-

3785 tility and dissemination and relieving the micro-organisms of their own attendant wastes, and this I believe to be the reason why liquefaction, decay and dissolution of solids by anaerobic action takes place so rapidly and inoffensively in large bodies of water.

3786 Where we cannot supply large bodies of water, or where it would be contrary to public policy to polute large bodies of water, it becomes evidently necessary, as far as possible, to imitate the conditions by which solids of sewage dissolve in large bodies of water, and this we must evidently do by providing a sufficient quantity of liquid in
3787 which the bacteria may multiply and disseminate, and in which if possible the wastes of their own existence may not injure them or decrease their vitality. This can be done by accumulating the sewage in the tanks, or by spreading it out on the top of filter beds of ample area, or by means of large bodies of flowing water, and it is always
3788 a matter of expediency which one of these methods we must necessarily select.

XQ. 32. Where enough dissolved oxygen is not available in water for nitrifying conditions, have you known of any attempts to stimulate the same nitrifying condition by blowing air into the sewage? A. I have. This seems to have been an idea
3789 which has occurred to a good many minds at various stages in the history of the art.

XQ. 33. To what extent have such attempts at purification survived up to the present time in practical use? A. There may be possibly one or two plants in this country operated in that manner,

but in my opinion there have been no important
survivals of that idea.

XQ. 34. What plants had you in mind in your
last answer, and by whom were they built if you
know? A. One plant I think, at East Cleveland,
or somewhere in the vicinity of Cleveland, occurs 3791
to me as having been built a few years ago on this
principle; also a plant by the late Colonel George
E. Waring was constructed at some street railway
park near Philadelphia, about 1899, I should
think.

XQ. 35. What in your opinion is the objection to
a plant operating on the principle last referred to, 3792
namely, the production of nitrifying conditions by
aerating the sewage or blowing air into it? A. I
have never formulated any objection, save to note
that such plants do not seem to be especially suc-
cessful. I should be inclined to believe that ex-
cessive agitation was detrimental to bacterial life,
both anaerobic and aerobic. 3793

XQ. 36. Do you understand that Colonel War-
ing, on March 12, 1895, patented a sewage disposal
plant operating on the principle of aerating the
sewage last referred to, being the patent now
shown you, No. 535,515, dated March 12, 1895? A.
I do. I am familiar in a general way with the
patent in question. 3794

Complainant's counsel offers in evidence a copy of the specification and drawing of the patent last referred to, and the same is marked Complainant's Exhibit Waring's Sewage Disposal Patent of 1895.

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XQ. 37. By question 15 you were asked to "enumerate the prior patents, publications and sewage disposal tanks or plants referred to in the testimony in this cause which you consider to apply or carry out the same process, that is, the process described in said patent and partic-
3796 ularly specified and claimed in its process claims." Among all the tanks referred to in your answers to questions 15 and 16 please give a list of all those that are not substantially represented for the purposes of this case by some one of the sketches on "Complainant's Exhibit Tracings Prior Art Cesspools?" A. The tank
3797 at the Worcester Hospital, the tank described in the Mueller patent, the tanks at Ealing, in England, at the School for Boys, at Lawrenceville, New Jersey, the plant at the Massachusetts Reformatory at Concord, at Altenheim and St. Joseph's Hospital, near Chicago, at Medfield, Massachusetts, the patent of Scott Moncrief, the
3798 tanks of Professor Talbot at Urbana and Champaign, the plants in England, at Aldershot, Wimbleton and Murton, the tanks described by Henry Austin in his report in 1862, the plant at Croyden, England, and at Gardner and Marlborough, Massachusetts.

XQ. 38. Please repeat the list of your last
3799 answer and give opposite each reference the name of the exhibit in this case to which you refer as showing it, or the reference by page to a book wherein such reference is shown, which book is competent for reference under the stipulation in this case? A. Repeating the last answer with references, I would say that the

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description of the tank at Worcester, Massachusetts, is found in book published in 1894 by Messrs. Rafter & Baker, entitled "Sewage Disposal in the United States, page 456;" German patent to Alexander Mueller, No. 9793, in 1878, which is an exhibit in this case. The tanks at
Ealing, in England, are described in a book published in London, in 1890, written by Mr. W. Santo Crimp, and entitled "Sewage Disposal Works," reference is to be found on page 161. The plant at the Lawrenceville School for Boys will be found in Messrs. Rafter & Baker's Book, on page 511. Description of the plant at the Mas- 3801
sachusetts Reformatory at Concord will be found 3802
in Messrs. Rafter & Baker's Book, page 465.

Description of the plants at Altenheim and St. Joseph's Orphan Asylum, near Chicago, are found in the testimony of Mr. W. S. MacHarg in this case, and the further description of the plant at St. Joseph's Orphan Asylum is found on page
386 of the Engineering & Building Record for 1889. 3803

A description of the plant at Medfield is to be found in the Annual Report of the Massachusetts State Board of Health at page 100, also in Rafter & Baker's book, page 490. The Scott Moncrief patent No. 530,622, granted December 11, 1804, is one of the exhibits in this case. The
description of the tanks at Champaign and Ur- 3804
bana is to be found in the testimony of Professor Talbot, and the drawings of the same are exhibits in this case. The plants at Wimbleton, in England, is described in Mr. Santo Crimp's book, page 216. The plant at Merton, England, is described in the same book, page 151.

3805

The plant at Croyden, England, is described in Mr. Santo Crimp's book, page 151. The plant at Gardner is described in Rafter & Baker's book, page 116, and the plant at Marlborough is described in the same book, page 504. The report of Henry Austin contains a description of a sug-
3806 gested tank of which a copy is marked "Defendants' Exhibit Proposed Sewage Works," also a drawing of tanks at Cheltenham, which is entitled "Defendants' Exhibit Cheltenham Sewage Works."

XQ. 39. For the convenience of the court, I make the following list of the references cited in
3807 your last two answers abbreviated and rearranged so that those occurring in the same book are together, and will ask you to state if it is substantially correct?

Worcester, Rafter & Baker................p. 456
Lawrenceville, " ....p. 511
Concord, " ....p. 465
3808 Medfield, " ....p. 490
Gardner, " ....p. 116
Marlborough, " ....p. 504
Ealing, Santo Crimp.....................p. 161
Wimbleton, " ....p. 216
Merton, " ....p. 151
3809 Croyden, " ....p. 151

Mueller, German patent, 9793, of 1878.
Scott Moncrief, U. S. patent, 530,622.
Altenheim, MacHarg testimony.
St. Joseph's, MacHarg testimony.
Urbana, Talbot testimony.
Champaign, Talbot testimony.

 3810

Defendants' Exhibit Proposed Sewage Works.
Defendants' Exhibit Cheltenham Sewage Works.

A. It seems to be correct.

XQ. 40. And as I understand you, the above
list contains all of the references given in your
answers to questions 15 and 16 that are not sub-
stantially represented for the purposes of this 3811
case by some one of the sketches on "Complain-
ants' Exhibit Tracings Prior Art Cesspools." Is
that so? A. They are so far as I now recall
them. I have, of course, omitted a considerable
number of plants which I consider to be substan-
tially of the type of one or the other of the draw-
ings upon complainant's exhibit. Among these 3812
are a considerable number of installations of the
type advocated by Colonel Waring, and modifica-
tions of the type patented by Mouras.

XQ. 41. Of all of the references enumerated in
XQ. 39, or represented by the sketches on "Com-
plainant's Exhibit Tracings Prior Art Cesspool,"
which one do you regard as the best and most exact 3813
anticipation of Claim 1 of the Cameron patent in
suit? A. I am unable to select one which I con-
sider more nearly covering Claim 1 than a large
number of the others.

XQ. 42. Do we mean to be understood as saying
that the court may select at random anyone of the
reference referred to in the last question and as- 3814
sume that in your opinion it is just as good and ex-
act an anticipation of Claim 1 as any other of said
references? A. I did not so state.

XQ. 43. Then please state which of those refer-
ences you regard as being on an equality, the best
and most exact anticipation of Claim 1? A. I re-

3815 gard the tanks at the Worcester State Hospital for the Insane, at the Massachusetts Reformatory at Concord, at the School for Boys at Lawrenceville, German patent, 9793 to Alexander Mueller, the installation at Altenheim and St. Joseph's Orphan Asylum near Chicago, the plant at Medfield, Massa-
3816 chusetts, the plants at Urbana and Champaign, Illinois, the plants at Wimbleton and Merton, in England, the tanks at Cheltenham described by Henry Austin, and his suggested tank as all being complete anticipations of Claim 1 of the patent. The remaining instances cited I regard as anticipations of Claim 1 of the patent, though perhaps
3817 slightly less clear so far as the records stand, in their intentional use of liquefaction.

XQ. 44. Would your last answer be any different if the question should be repeated as to Claims 2, 3, 4 and 21 respectively, of the Cameron patent in suit? A. It would not be, with the exception that at Urbana and Champaign there is no filtering op-
3818 eration to follow the aeration, as specified in Claim 4.

At one or two of the instances cited there is an inlet into the tank which is non-disturbing in the strictest sense. These instances are notably at Gardner, and in the tank suggested by Henry Austin, "Defendants' Exhibit, Proposed Sewage
3819 Works."

XQ. 45. I will now take up the references that you mentioned in your last two answers as the best and most exact anticipations of Claims 1, 2, 3, and 21, so as to have you point out on the drawing of each what you regard as the tank within which the processes of those claims were performed. Please point out on the drawing of the Worcester plant, (Rafter & Baker, p. 458), the tank in which you say that the process of said claims were performed? A. I beg to point out that the above question draws a wrong inference from my preceding answer; that the instances which I have given are not the best illustrations of anticipations of Claim 3821 1, but are the best illustrations of all those I have mentioned, excluding all instances which are substantially the same type as shown on "Defendants' Exhibit, Tracings, Prior Art Cesspools."

Complainant's cousel states that he does not understand the testimony of the Witness to read by any means as last stat- 3822 ed, but that if the witness insists upon so construing it, it is necessary for counsel to begin largely over again, and it is therefore futile for the witness to answer the last question with any such understanding.

XQ. 46. In XQ. 41 I asked you which of all the 3823 references enumerated in XQ. 39, or represented by the sketches and "Complainant's Exhibit, Tracings Prior Art Cesspools," you regarded as the best and most exact anticipation of Claim 1 of the Cameron patent in suit. In XQ. 43 I asked you to state which of those references you regarded as being on an equality the best and most exact anticipation of 3824 Claim 1. I therefore repeat XQ. 43 which you now see includes all of the references enumerated in XQ. 39, as well as all the references represented by the sketches on "Complainant's Exhibit, Tracings, Prior Art Cesspools," and therefore include all of the references cited by you in answers 15 and

3825
16? It will greatly simplify matters for the Court
if, in answering this question, you will refrain from
repeating different references descripitive of sub-
stantially the same thing. A. I now perceive that
I misunderstood your XQ. 41 to exclude anticipa-
tions substantially like those shown by the "Com-
3826 plainant's Exhibit, Tracings, Prior Art Cesspools,"
and to the answer to XQ. 43 which will remain as
I then answered it, I will add the U. S. patent, No.
268,120, to Louis Mouras, in 1882, the installations
of the Flush-Tank Company as instanced at Blair
Lodge, Lake Forest, Ilinois, the tank at St. Bede's
College, near Peru, Illinois, as testified to by Mr.
3827 Hill and Mr. Burdick, and the tanks described by
Professor Pagliani in the International Congress
of Hygiene, 1891.

Adjourned till to-morrow, Friday, September 15, 1905, at ten o'clock A. M.

Friday, Sept. 15, 1905, ten o'clock A. M.; met
3828 pursuant to adjournment; present as before.

XQ. 47. Would your answer to the last question
be any different if it should be asked with reference
to Claims 2, 3 and 21 respectively? A. It would
not with the exceptions that some few of the in-
stances noted, notably at St. Bede's College, at
Peru, Illinois, in the suggested tank of Henry Aus-
3829 tin, in the tanks at Altenheim, and St. Joseph's
Hospital, near Chicago, there are not strictly
speaking non-disturbing inflows in the sense that
these inflows are at mid-depth. In the case of most
of these exceptions, however, these inflows are non-
disturbing by reason of the small proportion of the
inflow in relation to the liquid contents of the tank.

In nearly all of the cases cited the outlet is non-disturbing.

XQ. 48. In respect to which of the Claims 2, 3 or 21, do you wish to make the exceptions, noted in your last answer? A. Claims 2 and 3.

XQ. 49. To get a complete list together of all the references cited by you from the prior art that 3831
you regard as being on an equality the best and most exact anticipation of Claims 2 and 3, I make the following, and ask you if it is correct:

Worcester, Rafter & Baker..............p. 456
Lawrenceville, " ....p. 511
Concord, " ....p. 568
Medfield, " ....p. 490 3832
Wimbleton, Santo Crimp.................p. 216
Merton, " ....p. 151
Mueller, German patent, 9793 of 1878.
Urbana, Talbot Testimony.
Champaign, " "
Defendants' Exhibit, Cheltenham Sewage Works.
Mouras U. S. patent, No. 268,120. 3833
Flush-Tank Company Catalogue...........p. 24

A. It is, and I should like to add to the list, the plant at Ealing, in England, (Santo Crimp, p. 158) as meeting the requirements of my previous questions and answers.

XQ. 50. Please take up each of the references mentioned in the last question and answer and des- 3834
ignate what tank shown in the drawing of each, you regard as containing or producing the process of Claims 2 and 3. In answering this question, I would suggest that it would be for the convenience of the Court if you referred to each reference by a separate paragraph commenced by the distinctive

3835 name of the reference, and that you designate the particular part of the apparatus to which you refer in as few words as possible? A. I will first refer to:

Worcester Hospital for the Insane—(Rafter & Baker, p. 456).

3836 This plant shows a covered tank by means of which light and air are practically excluded, having a non-disturbing inflow and outflow. The tank is shown on Fig. 69, page 458, as an oblong tank with rounded ends, denoted in plan by E, also in section corresponding to and immediately above same.

3837 **Lawrenceville School for Boys**—Rafter & Baker, p. 511).

A cut of the tank at Lawrenceville is found on page 512, Fig. 91, which shows the tank in plan, and immediately above it in longitudinal section corresponding with the plan, and in addition two transverse sections on line A, B and C, D of the
3838 plan.

There is also a small plan of the same tank in Fig. 92, page 513, marked in the cut, "Sewage Tank," which shows its general relation to the irrigation ground.

A description of the tank is found on page 511 near the bottom of the page, under the heading of
3839 "Sewage Disposal System," and extending to and including the top paragraph of page 513.

Concord Massachusetts Reformatory—Rafter & Baker, p. 468).

The tank in this case in its general relation to the plant is noted on Fig. 72, page 469, and marked "Sewage Reservoir Pump House." A more com-

plete detail of the tank is shown in Fig. 73, page 470, in plan, and immediately above the plan by a longitudinal section corresponding therewith and marked "Section on E, F." The liquefying tanks proper are those marked on plan "AA," the tanks marked "BB," being receiving storage chambers from which the sewage flows after leaving the tanks 3841
A and A."

A description of the tanks is found on page 471, beginning at the top of the page in small type, and extending to and including the upper two paragraphs on page 472.

Medfield Plant, Massachusetts—Rafter & Baker, p. 490). 3842

The tank at Medfield will be found in Fig. 79, showing a section through its center line in either direction, but no plan. This may be called the main tank. A second tank is built and connected in the sewer leading from the main tank which is shown at Fig 80, page 492, in plan and section.

A description of the main tank begins with the 3843
bottom paragraph on page 490, and extends to and including the upper paragraphs of page 491. A description of the second tank is found in the second paragraph of page 491.

Wimbleton, England—(Santo Crimp, p. 216.)

The tank here is shown on plate 25, opposite 3844
page 215, and consists of a plan with a section below and correspondent.

A description of the tanks begins near the top of page 216, and continues to and including the second paragraph on page 217.

Merton, England—(Santo Crimp, p. 151.)

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A section of the straining tank appears on plate 12, opposite page 149. There is apparently no plan.

A description of the tanks is found in the second paragraph on page 151.

Mueller German Patent, 9792, of 1878. (Defendants' Exhibit, Translation of Mueller's German Patent).
3846

There is no drawing accompanying this exhibit.

A description of the tank is found beginning with the bottom paragraph of page 2, extending to and including the top paragraph of page 3.

Urbana, Illinois—(Talbot's Testimony in this case).

3847 The tank is described in Professor Talbot's testimony, and a drawing of the same is found marked "Defendants' Exhibit Urbana Tank, November, 1894;" also an exhibit marked "Defendants' Exhibit, Prof. Talbot's Preliminary Sketch, Aug. 2nd, 1905." In the preliminary sketch the tank is denoted in plan near the center of the sheet, and im-
3848 mediately above and in longitudinal section corresponding to the plan. In the exhibit, "Urbana Tank, November, 1894," the tank is shown in plan about the center of the sheet, and immediately above and corresponding to the plan is shown a longitudinal section.

Champaign, Illinois—(Talbot's Testimony in
3849 this case).

This tank is described in Professor Talbot's testimony in this case, and is also shown in a drawing marked "Defendants' Exhibit, Champaign Tank, Drawing No. 2, August 2nd, 1905." In this drawing, the tank is shown in plan near the bottom of the sheet to the left, marked "Plan with Roof Re-

moved." Immediately above and corresponding to the plan is a longitudinal section marked, "Section AB," and in the upper right hand corner of the drawing is a transverse section, marked, "Section CD." The second Champaign tank is also shown by a drawing marked, "Defendants' Exhibit, Champaign Tank Drawing, No. 1," which shows the tank 3851
in the upper central portion of the sheet marked, "Plan," and immediately above and corresponding is a longitudinal section marked, "Section AA." In the upper right hand corner is a transverse section marked, "Section BB."

Cheltenham Sewage Works—(Defendants' Exhibit, Cheltenham Sewage Works). 3852

The tank is shown in the lower part of the drawing, immediately over it, but not corresponding, is a longitudinal section marked, "Longitudinal Section Through Tank on Line AB." In the upper right hand corner is shown a transverse section marked "Transverse Section on Line C D."

The description of this tank is part of the exhibit. 3853

United States Patent, No. 268,120, to L. Mouras, November 26, 1882.

There are two drawings connected with the patent in both of which the tank is shown at the right, in the first sheet with plan and corresponding section immediately above, and in the second sheet by 3854
two sections.

A description is also found in French patent, No. 144,904, 1881, marked, "Defendants' Exhibit, Translation of Specification of Mouras French Patent."

Flush-Tank Company, Chicago.

This type of tank is shown in the drawing on page 24 of a pamphlet entitled, "Intermittent Flush Tanks, Flush-Tank Company, Chicago," and marked, "Defendants' Exhibit, Catalogue of Flush-Tank Company, Chicago."

3856 The cut referred to, shows the tank in question as being the left hand tank of the two chambers in the drawing, and marked, "Intercepting Chamber."

A description of the tank is given, beginning with the top paragraph on page 24, and ending with the top paragraph on page 25.

3857 A second cut, No. 3, page 26, shows a general arrangement of the same with reference to the house and garden.

Ealing, England—(Santo Crimp, page 158.)

The tanks in question are shown on plate 14, opposite page 158, and are marked on said plate, "Subsiding Tanks, No. 1 and No. 2, and Effluent
3858 Water Tanks."

A description of the tank begins at the bottom paragraph of page 158, and extends through to the end of the chapter.

XQ. 51. Turning to Lawrenceville (Rafter & Baker, p. 512), the description says that each section of the tank is divided into three compartments,
3859 each compartment being 60 feet long, about 3 feet wide, and 4 feet deep. In which of these three compartments in your opinion would the process of Claims 2 and 3 occur? A. I am of the opinion that it would occur in all of them..

XQ. 52. What do you understand the dotted line marked, "Flow Line," in the "longitudinal section," and in the "section on line CD" to indicate? A. The ordinary level of the liquid retained in the tank as controlled by the overflow at the outlet end.

XQ. 53. Assuming that each compartment was about four feet deep, as stated in the description, and that the surface of the sewage was indicated
by this dotted flow line, about what would be the 3861
depth of the sewage in the compartment? A. I should judge that it would be four feet in depth, as from an examination of "Section on Line CD," the dotted line appears to be about four feet above the bottom upon the assumption that the width is as stated, three feet. I take, it, therefore, that the
description of each compartment giving four feet 3862
depth refers to the depth below the flow line.

XQ. 54. In your opinion, in the operation of this Lawrenceville tank, if it should operate as a septic tank, as you suppose, what thickness of scum would form on the surface, and what depth of sludge at the bottom of the compartment? A. I
think it would be impossible to say without know- 3863
ing more of the analysis of the raw sewage and the quanity flowing through the tank per day.

XQ. 55. Is there anything in the drawing or description of the Lawrenceville tank to show the quantity flowing through the tank per day? A. On page 514 I find it stated that the amount of sewage
water averages 6,000 gallons a day, and apparently 3864
this refers to some period previous to the publication of Rafter & Baker's book, for in comments upon this description in the bottom paragraph of page 514, I find it stated that the amount of sewage at Lawrenceville "has gradually increased until in 1893 it averages during the school term about

20,000 gallons per day." On the top of page 515 it is stated that on July 24, 1893, the school not being in session, the daily amount of sewage averaged only 5,000 or 6,000 galons per day.

XQ. 56. Does the drawing or description of this Lawrenceville reference give any indication as to
3866 the quality of the sewage? A. I find on page 514 that it is stated: "The regular number of persons now using the water and contributing to the sewage is one hundred and eighty. The works are designed to accommodate four hundred people. The water supply for all purposes, averaged 8,000 gallons a day in 1886, varying from 6,000 gallons
3867 a day in April, to 25,000 gallons a day during one week in October, 1886, when the lawns were very dry and a new sprinkling cart was put into use on the lawns and roads." This amount of flow would denote the sewage fairly well concentrated.

XQ. 57. Can you state from the indications as to quantity and quality of the sewage referred to in
3868 your last two answers what should be the thickness of the scum on the surface and the depth of the sludge at the bottom of the compartment, if the Lawrenceville tank were operating as a successful septic tank? A. I do not think I could make any exact determination of either the thickness of the top scum or the amount of deposit, other than to
3869 say that in all probability there would be such deposit and such scum with the flow of sewage as given from the number of persons as stated, and in a tank designed as this one was. The scum will vary very much as the specific gravity of the solids of the sewage varies, and this is also the case with the bottom deposit. I have seen tanks where rapid

liquefaction was taking place which had no surface scum, and I have observed other tanks which had a very thick surface scum and no apparent bottom deposits. I should think, therefore, from my experience, that the present knowledge of the art is such that no fixed rule could be laid down, or even a very general rule. 3871

XQ. 58. Can you state what should be the thickness, taking the thickness of the scum and the thickness of the deposit together? A. I do not think that I could. The thickness of the total top scum and bottom deposit is dependent upon the length of time which elapses between the cleaning which such tank often receives, and is also depen- 3872
dent on the character of the sewage and the amount of cellulose and fibrous matter which it contains, the preliminary screening, if any, and other like variables.

XQ. 59. As I understand you, the description that you have referred to of this Lawrenceville plant is insufficient to enable you to furnish these 3873
determinations? A. Insofar as you refer to the formation of the exact quantities of surface scum or bottom sludge I should answer yes, but insofar as determining whether liquefaction took place, I should answer, no.

XQ. 60. What do you understand from the description of the Lawrenceville tank to have been 3874
the total amount of liquid that passed through the tank per day? A. From six thousand to twenty-five thousand gallons; normally, however, from six to eight thousand gallons.

XQ. 61. In your reference to the Medfield drawing and description (Rafter & Baker, p. 490), you

3875

refer to the two tanks, one being shown in Fig. 79, and the other in Fig. 80. In which of these do you mean to be understood as saying that the process of Claims 2 and 3 would occur? A. It would appear to me that the larger part of the process would occur in the main tank shown in Fig. 79. I am of
3876 the opinion, however, that additional action might be obtained from the second tank, shown in Fig. 80, inasmuch as it seems to me from the description that this second tank may be reasonably considered as an additional compartment to the main tank placed at some distance from it, perhaps, but nevertheless so designed that liquefaction from some of
3877 the finer particles of solids might be accomplished by the retention of the flow in the second tank.

XQ. 62. In classing this Medfield plant as one of the most exact and best anticipations of Claims 2 and 3, which tank had you reference to whether that shown in Fig. 79 or Fig. 80? A. I should be willing to consider that shown in Fig. 79 alone if
3878 necessary with, of course, the aeration of the effluent arising from its further treatment.

XQ. 63. I do not exactly understand your last remark. What has the aeration of the effluent to do with the question whether the Medfield tank of Fig. 79 constitutes one of the best and most exact anticipations of claims 2 and 3? A.
3879 Claim 3 calls for a combination with an aerating operation. This aerating operation in the Medfield plant is accomplished in the tank shown in Fig. 80. Therefore, if you eliminate Fig. 80 from consideration the aerating combination must be looked for at the outlet that leads from the tank to the filtration field.

XQ. 64. How would the Medfield tank shown in Fig. 80 produce an aerating operation? A. The inlet to the tank shown in Fig. 80, which is, of course, the outlet from the main tank, empties the effluent into the tank a little above the flow line, in the course of which aeration of necessity occurs. 3881

XQ. 65. Do you understand that the Medfield tank shown in Fig. 80 is closed by a cover? A. Yes, sir.

XQ. 66. What do you understand to be the width of the tank shown in Fig. 79 of the Medfield tank? A. It seems to be 13 feet wide outside dimensions. The inside appears to be di- 3882
vided into two longitudinal compartments of 5 foot width each.

XQ. 67. Is there anything in this Medfield description to show that the two tanks that are side by side in "Section A B of Fig. 79." were not used alternately? A. At the bottom of page 490
it is stated: "It is made in two parts, side by 3883
side, exactly alike, in order that one-half may be in use, if necessary, while the other is being cleaned out." The discharge from the vats can be turned, by a wooden gate in the trough which brings it from the dye house, into either side of the settling basin separately. Entering by the
four-inch openings the liquid flows generally in 3884
both sides, with a total width of ten feet and a depth of four feet, less the thickness of the deposit of sediment."

XQ. 68. And what do you understand would be the total length of the tank shown in Fig. 79 in which the septic action would take place? A.

3885 The total length available for liquid contents appears to be twenty-four feet, being made up of three compartments of eight feet each, exclusive of cross walls.

XQ. 69. Then as I understand you, you include
3886 the space occupied by the "excelsior between slats" as a portion of what you consider to be the septic tank on Fig. 79. Is that so? A. Yes, sir, I should consider that space as available for liquefaction of the more finely divided solids.

XQ. 70. In the Wimbleton plant (Santo Crimp, p. 216) do you include the space occupied by the
3887 "filters L" as a portion of what you have referred to in that plant as the septic tank? A. Yes, sir, I conceive that the finer particles of organic sediment may pass up into the interstices of the filtering material and there be mechanically arrested by contact with such filtering material and held until the liquefaction is more or less complete. The actual space occupied by the
3888 solid substance of which the filtering material is composed is, of course, not to be included in the computation for capacity.

XQ. 71. What you have designated as the septic tanks of this Wimbleton reference are in the description of it (Santo Crimp, p. 216) referred
3889 to as "straining tanks" or "screening chambers." Is that so? A. They are so referred to by Mr. Santo Crimp, but apparently this designation is his own, and not the designer of the tanks. Mr. Santo Crimp is everywhere and always an ardent believer in chemical precipitation, and in my opinion is not a sympathetic in-

terpreter of those designers who endeavored to follow the suggestions of Mr. Henry Austin.

XQ. 72. In the description to which you have referred of the Merton plant (Santo Crimp, p. 151) are the tanks that you have regarded as septic tanks those designated in that description
as "merely straining tanks, being much too small 3891
to act as settling tanks?" A. Mr. Santo Crimp does so refer to these tanks which I take to be another instance of his inability to perceive the ideas of the designer of this plant, and what appears to me to be the designer's evident intention to carry out by means of baffle boards and
submerged outlet, the ideas suggested by Henry 3892
Austin for the preliminary treatment of the solids of sewage.

> The last two answers of the witness are objected to as inadmissible, being in the nature of a contradiction of the only evidence that the defendants
> have introduced showing the publica- 3893
> tion of the plants referred to.

XQ. 73. In the Cheltenham plant are the tanks that you have referred to as septic tanks those referred to by the following language in "Defendants' Exhibit Cheltenham Sewage Works":
"The sewage passes through vertical filters in 3894
the upper and lower tanks, whereby the great bulk of the matters in suspension is separated and retained. These filters are 5 feet deep and 2 feet thick, and consist of coarse gravel enclosed within 2-inch perforated boards, these being protected with basket-work to prevent clogging. . .

3895

. . . . When either reservoir contains a certain amount of solid matter the flow of sewage is cut off and turned into the other. This takes place about every eight weeks and the filtering medium of gravel is removed at the same time and washed. The contents of the tank
3896 which are in a state of slush are then hoisted in buckets through the trap lids onto the floor above and wheeled out and mixed with the scavenger's refuse of the town, the ashes, street sweepings, etc.?" A. The quotations are correct. The arrangement of tanks and filters referred to as shown in the drawing are such as to retain the
3897 liquid flow of the sewage a sufficient length of time to accomplish liquefaction. The solids are further held back in the tank by means of the submerged filters which cause the finer organic matters to be mechanically detained and liquefied before passing on into the next compartment. The arrangement is such that the liquid
3898 flows very slowly through the filters from one compartment to another. That the liquefaction was proceeding satisfactorily is evidenced from the following further quotations of the description:

"The heavier matters of the sewage deposit themselves at the bottom of the tank but a large propor-
3899 tion of the solids forms itself into a floating body and accumulates to about 18 inches thick on the surface. . . . A weir or rather division in the third or liming tank causes the water then partially clear to flow through a channel at each end. . . . . . The operation did not appear to give rise to any nuisance and the effluent water and solid sewage were nearly free from unpleasant odor."

The answer is objected to as irresponsive and the question repeated.

A. These tanks are the tanks referred to in the question.

XQ. 74. The question is are the tanks in the Cheltenham plant that you have referred to as septic tanks those that are referred to in "Defendants' Exhibit Cheltenham Sewage Works" 3901 by the language quoted in XQ. 73? A. I am not aware that I used the word septic in describing the Cheltenham tank, but I have referred to the Cheltenham tank in my previous answer as being an anticipation of the patent, and these tanks from which you have quoted the description and 3902 from which I have made further quotation are the same tanks.

XQ. 75. As to the Flush-Tank Company reference shown on page 24 of the catalogue, you have stated that the tank within which you say the process of claims 2 and 3 would occur is that marked "intercepting chamber." Do you mean 3903 to say that this process would occur on both sides of the partition shown in said chamber? A. I believe that it will occur on both sides of the division shown in said intercepting chamber. The preponderence of liquefaction of solids, however, taking place in the inlet compartment of such chamber by reason of the fact that the heavier 3904 solids are deposited there to a greater extent. As fast as these break down into the more finely divided particles they pass with the liquid over the dividing wall and are further liquefied by bacterial action in the second or outlet compartment of said intercepting chamber.

XQ. 76. Besides the tanks of this kind that you mentioned in your answer to XQ. 19, have you heard of any others in use at the present time, and if so where? A. I have seen a considerable number of other installations of the type here described, but I cannot now recall with-
3906 out considerable effort, or reference to note books, where they are located. I am under the impression that there are a very large number of these installations in this country, but as they are not commonly described in technical literature, or listed by their designers in such way as to be available, they cannot be cited except by
3907 specific instances which come readily to mind. They have been for the most part constructed by architects in pursuance of their general duties in the supervision of country residences and large institutions, and only a small portion of them come directly to the notice of the sanitary engineer. Nevertheless, as I have said, I am
3908 quite confident that in the last 25 years of my experience I have seen a considerable number that I cannot here and now recall.

XQ. 77. Do you know whether either of those installations mentioned in answer to XQ. 19 is still in operation? A. I should be unable to say.

XQ. 78. Will you please, before the next ses-
3909 sion, make such an effort as you can with the aid of your note books to recall and state where you have seen other installations of this character? A. Yes, sir, I will do so.

XQ. 79. Please designate all of the references cited by you from the prior art that you regard as being on an equality the best and most exact

anticipations of claim 4 of the patent in suit? You may answer this question, if you wish, by referring to the list in XQ. 49 and the answer thereto, and stating which would have to be omitted from that list in answer to the present question? A. I should eliminate the tanks at
Urbana and Champaign, and the "Defendants' 3911
Exhibit Cheltenham Sewage Works" from the list, the remainder, in my opinion, being anticipations of claim 4.

XQ. 80. Why do you eliminate those designated in your last answer? A. Because I do not find evidence that they are combined with the fil-
tering operation. 3912

XQ. 81. In those references that you have eliminated as not showing filtering operations, what disposition is made of the effluent from the tank? A. In the case of Champaign and Urbana tanks, the effluent flows into a running stream. In the case of the Cheltenham sewage works I am
unable to determine whether there is or is not 3913
a filtering operation following the works as described in "Defendants' Exhibit Cheltenham Sewage Works."

XQ. 82. In which of the references cited in XQ. 49 and the answer thereto is the effluent from the tank finely disposed of by sub-surface irriga-
tion of vegetation? A. The plant at Lawrence- 3914
ville, New Jersey, and the plants derived from the suggestions of Colonel George E. Waring, of which Blair Lodge is here instanced, and represented in Flush-Tank Company's catalogue.

XQ. 83. Have you ever seen a tank that had become nearly filled up with the accumulation

3915 of solids from sewage passing through it? A. Yes, sir, I have seen tanks nearly full with the solids of sewage, but through which the sewage flow was still passing.

XQ. 84. What effect upon the rest period of the sewage passing through does the filling up
3916 of the tank till it is nearly full of solid matter produce? A. It very seriously reduces the rest period within the tank.

XQ. 85. What effect does that have upon the function of the tank as a settling or sedimentation tank for the separation of the solids of the incoming sewage? A. It undoubtedly reduces
3917 its usefulness materially.

XQ. 86. Suppose the tank should be permitted to get so full of the solid matter as to leave only just room enough for the passage of the incoming sewage from its inlet to its outlet, what effect would that have upon the effluent from the tank so far as the retention of the solids as sol-
3918 ids in such effluent was concerned? A. It would undoubtedly cause most of the solid matter of the original sewage to reappear in the effluent without serious change.

XQ. 87. Under such circumstances would you consider that such tank was operating substantially as a successful septic tank? A. I should
3919 not think it operating as a successful septic tank ought to operate, but I would be of the opinion, nevertheless, that even under such extreme circumstances some small reduction of organic matters within the tank was constantly going on.

XQ. 88. Is the following an excerpt from a pamphlet of which you were the author and pub-

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lished by you about April, 1903, entitled "The Practical Operation of Sewage Purification Plants":

"Some septic tanks are subject to the fault that the sewage enters them in such a way that it evidently traces a patch through the center so that the stay of the liquid and its accompanying particles 3921
of matter is not so well averaged in its relation to the total capacity. This difficulty can only be obviated by modifications in design which will more evenly distribute the incoming sewage on the entering side. By the experimental use of coloring matter it has been observed that great improvement may be made in evening the flow by multiplying the number of inlets and carefully arranging that the liquid shall be as evenly divided between them 3922
as possible, thus avoiding the difficulty of having a certain quantity pass through the tank in a fourth or a third of the time denoted by the ratio of the capacity to the entering volume."

A. It is.

XQ. 88. In what form of tank have you observed the liquid to trace a path through the center as you stated in the excerpt quoted in the 3923
last question? A. In deep circular tanks, that is to say, tanks having the shape of a cylinder set up on end in which the flow of incoming sewage was quite large relatively to the capacity to the tank, and in which there was no dividing baffle wall.

XQ. 89. What size of tank had you reference 3924
to in the last answer? State the diameter of the cylinder and the depth of the liquid in it. A. To the best of my recollection the diameter was about ten feet and the depth below the surface of the liquid was about eight feet.

XQ. 90. And how far apart were the inlet and

outlet openings and where located? A. The in-
let and outlet openings were made with elbow
pipes turned down to discharge and empty the
contents from a point below the surface. I am
under the impression that they were about eight
and one-half feet apart from center to center.

3926 XQ. 91. What means did you adopt to de-
termine that the sewage, as you said, "evidently
traces a path through the center"? A. At a
time when the tank was filled with comparatively
fresh flow of dilute sewage which was not
cloudy I deposited a small quantity of fluroscene
in the sewer immediately above the tank and
3927 studied it as it colored the water of the tank.
There was flowing into the tank at this time
about 15,000 gallons a day. I also introduced
into the tank a number of baffle walls of light
flooring stuff and studied their effect upon the
passage through the tank by repeating the doses
of coloring matter with each change of baffle
3928 board.

XQ. 92. Before you introduced the baffle
boards what did you observe upon the introduc-
tion of the fluroscene in the sewer above the
tank? A. The coloring matter, while it widened
out considerably upon escaping from the inlet
3929 pipe, nevertheless traced a fairly direct passage
from the inlet to the outlet and was a little over
an hour and a half, as near as I remember it, in
coloring the entire contents in the tank.

XQ. 93. Did you observe how long the first trace of color was in passing from the inlet to the outlet? A. I do not remember the exact figures, but I am under the impression that it was less than five minutes.

XQ. 94. What do you understand to be the nature and mode of operation of the "Coke-Breeze Filters" referred to in the Cameron patent in suit at page 2, line 32? A. I understand to be
meant the use of what are now more commonly 3931
called contact beds, that is to say, tanks constructed so as to be water-tight and filled with a suitable medium, such as gravel, broken stone, or, as in this case, the waste obtained in the manufacture of coke, such tanks being operated by filling them with sewage, or the effluent from
septic tanks, allowing them to stand full for sev- 3932
eral hours, and then emptying them by means of suitable valves, the filtering material being allowed to aerate a suitable length of time the cycle of operation is again repeated.

XQ. 95. Where are the valves generally located by which such coke-breeze filters are
emptied after being allowed to stand full for sev- 3933
eral hours? A. The valves are generally located in the bottom of the filter tank in one of the walls of the same. The bottom is generally so arranged as to drain toward the outlet valve as described.

Adjourned till Saturday, September 16, 1905, at 10 o'clock A. M.

Saturday, Sept. 16, 1905, 10 o'clock, a. m. Met 3934
pursuant to adjournment. Present, as before.

XQ. 96. Did you state as follows, in a paper written by you and published in the Journal of the Western Society of Engineers, April, 1902:

"Effluents from septic tanks that are being properly worked seem to be very easily oxidized. The

3935 organic matter contained is largely in solution and in such a condition of instability that it is ready to break down into its constitutional gases without difficulty. Nitrification sets in promptly and the passage through a single intermittent sand filter will usually leave but one or two per cent of organic matter in the final effluent. The economy, there-
3936 fore, of the septic tank is not alone that no expensive machinery is required, or a large amount of labor to perform its function; nor is it due entirely to the fact that eliminates into harmless gases a large portion of the sludge left in it, but it is also essentially in the fact that it enables the effluent to be filtered at very high rates of flow through small areas of soil or compactly constructed contact beds occupying but little space."

* * * * *

3937 "In order to fully appreciate some of the modifications which have been brought about in the filtering of septic tank effluents, it is necessary to remember that the Massachusetts State Board of Health experiments have shown that in order to filter raw sewage successfully upon fine sand beds, an acre of bed is necessary for each 16,000 to 20,000 gallons of sewage per day. With somewhat coarser sand from 30,000 to 40,000 gallons per day of raw
3938 sewage can be filtered, while with very coarse sand there is a possibility of passing from 100,000 to 150,000 gallons per day if the beds are kept well raked. With septic tank effluents where there is but little suspended matter to deal with, and the liquid is ripe for oxidation, even with quite fine sand at least 200,000 gallons per acre per day can be filtered, with coarser sand, 350,000 gallons would be
3939 a safe allowance; while with the coarsest and most desirable sand at least 500,000 gallons per acre per day is possible. The difference between these figures is this, that if you have a plant that must purify the sewage of 2,500 people by the older method of intermittent filtration alone, you would require (at 100 gallons per capita) not less than seven acres of sand bed for medium sized sand, and if the available sand was quite fine this would

become 14 acres. If the sand had to be brought from any considerable distance the beds would cost complete not less than $10,000 per acre, or from $70,000 to $140,000 for the plant. Now, considering the absubstitution of the septic tank preliminary to the filtration, and you would at once reduce the cost for filtration area to about three-
fourths of an acre, and you might easily afford 3941
the coarsest sand brought from a great distance for the beds, which even then could be worked at a rate not exceeding 300,000 gallons per acre per day, and the entire plant would cost not more than $15,000, including the septic tank. Compare this with the $70,000 to $140,000 mentioned before, and some of the enormous advantages of the latter can be appreciated, especially in unfavor-
able localities. Not only in first cost, but also in 3942
operating expenses, simple intermittent filtration alone would cost at least twice if not three times greater than that necessary for the septic tank installation. Such a comparison as this I have just described is not at all uncommon, and is simply revolutionary in its results. It permits cities to own and operate sewage purification plants to whom it has been heretofore impossible. It al-
lows plants to be built in localities where every 3943
advantage is lacking, and it permits the problem to be brought within workable limits for the largest cities of this country. In bacterial contact plants the results are still more favorable as to the rates of flow. With septic tanks effluents most of these contact bed plants are worked at the rate of 500,000 to 750,000 gallons per acre per day, with the same rates of reduced cost for main-
tenance, and it is questionable whether a rate of 3944
1,000,000 gallons per acre per day for dilute American sewage is not fairly practicable."

A. I did so state, and in this connection I may say that I have been for some years a believer in liquefaction as a valuable preliminary stage in sewage purification.

XQ. 97. Please explain your meaning where you stated in the above quotation that the liquid of the septic tank effluent "is ripe for oxidation?" A. I think the paragraph in question would be best explained by a quotation from the same paper referred to in the question on page 115, as follows:

3946 "The second stage of purification consists of removing the more finely suspended residue and the impurities in solution. There are many ways of accomplishing this, known by different names, but the general principle underlying them all is that the liquid to be purified must be brought into contact by wide diffusion at enumeral points with certain forms of nitrifying bacteria in the presence of a sufficient supply of oxygen and re-
3947 tained under such conditions a proper length of time for complete chemical change to be accomplished; this properly done, the liquid is found to be purified. Most of the methods by which this principle is practically applied involve intermittency of application of the liquid to the filter and its alternating aeration. This second stage involves processes commonly known as broad irrigation, intermittent filtration, bacterial contact-
3948 beds, filters with forced aeration and continuous filters."

I might add to this that the liquid is ripe for such oxidation when it has been freed from the larger lumps of solids in which process it has probably taken into solution a proportion of their constituents which have been chemically broken down from
3949 higher complex forms into those which are comparatively more simple, but which are not yet completely reduced.

XQ. 98. Then, as I understand you, there are substantially two reasons why the preliminary septic treatment co-operates beneficially with the subsequent filtration. (1) A physical reason in that the lumps of solid matter in the sewage are reduced and (2) A chemical reason in that the higher complex constitution of the sewage has been transformed into comparatively more simple constitution which is more readily acted upon by the nitrifying bacteria of the filter. Is that so? A. I think the question is a fair statement of my views. 3951

XQ. 99. As you understand it, in what part of the septic tank do these changes go on? Are they confined to the proximity of the surface of the scum and sludge, or do they go on also throughout the body of the liquid, flowing between the sludge and scum through the tank? A. I do not believe that these changes are confined to the septic tank, but 3952
begin from the moment the organic wastes of life are created. The action is undoubtedly accelerated in properly designed tanks because it is or should be the attempt in designing such tanks to create the very condition which will accelerate such action. I believe further that the action which, as I have stated nearly always in my opinion has already be- 3953
gun before the solids have reached the tank is continued in every portion of the tank both in the surface scum and the bottom deposit and in the liquid contents. The surface scum being generally composed of cellulose and fibrous matters, is reduced somewhat more slowly, in my opinion, than are the solid faces. The bottom deposit which to some 3954
extent has contained mineral matter is also somewhat more slowly broken down. The organic matters which are rapidly dissolved are distributed quite uniformly through the liquid contents so far as my observation has gone, and it is my belief that this dissolving action is continued after the liquid

3955 leaves the tank to a certain extent, especially in cases where the sewage is allowed to flow some distance before reaching the filtration area. And I am also convinced from observation that the final stages of such liquefaction often take place on the surface of the filter, as is the case when raw sew-
3956 age is filtered through sand filters. In other words, I believe that we cannot arrest this liquefying action except by submitting the sewage to excessive heat or antiseptic chemicals: but I do believe that we may accelerate it by providing a suitable environment.

XQ. 100. What did you mean in your last answer
3957 by "properly designed tanks," by which the action you have referred to is accelerated? A. So far as present knowledge of the art goes, properly designed tanks should be such as will bring the sewage to a state of comparative rest and keep it at as high a temperature as it is possible to produce with the normal chemical action which is going on. Such
3958 tanks should have a sufficient depth to provide for considerable deposits, and to allow for accumulation of surface scum while not seriously reducing the liquid contents. In my opinion, means for excluding light and air are unnecessary, but I have found it desirable in colder climates to provide some lighter form of covering which, while not pre-
3959 venting ventilation, will nevertheless retain as far as possible the heat developed by the chemical action going on within the sewage itself. I regard non-disturbing inflow and outflow as relatively unimportant in such tanks as have a large capacity in proportion to the quantity of inflow. In cases where the inflow is very great, it is desirable to pro-

vide means, such as I have pointed out as common to the art, to prevent disturbance of the surface scum.

These I consider essential and desirable provisions for promoting liquefaction in tanks.

XQ. 101. In the same paper quoted in XQ. 96, on page 123, I find you use the expression, "the 3961
septic action, seemed to equal the rate of inflow of suspended matter." Is the approximation to this condition the object of a properly designed septic tank? A. The statement quoted is a rather broad one, but the idea which it is intended to convey was that the larger lumps of solid matter were readily retained within the tank until broken down into 3962
finely suspended matter, without accumulating the bottom deposits or surface scum too rapidly.

With this explanation I would say that it is the object of a properly designed septic tank to realize this condition.

XQ. 102. In order to approximate this condition wherein, as you expressed it, "the septic action 3963
seemed to equal the rate of inflow of suspended matter," is it essential that regard be had to such features of the tank as control the time during which the sewage is maintained in a state of comparative rest, at the temperature produced by the normal chemical action in the sewage itself? A. I have believed for some years that this was an im- 3964
portant element to be considered.

XQ. 103. In answer to Question 12, you stated, "I might observe that the question of disturbance in this case is a question of the relative volume of inflow to the quantity of sewage remaining in the tank." Will you please explain how this relation-

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ship between the volume of inflow and the quantity
of sewage in the tank can, in any case, effect the
question of disturbance? A. It is impossible for
any liquid flowing into a tank through any of the
devices which have here been considered in this
case to theoretically prevent disturbance, and it is,
3966 therefore, only a question of the relative amount of
disturbance which such inflow will create. In
cases where the capacity of the tank is very great in
proportion to the incoming sewage, it may readily
happen that the disturbance created by the dis-
placement of the inflowing sewage is so insignifi-
cant that it does not perceptibly retard the decom-
3967 position or liquefaction of the solids within the
tank. On the other hand, taking the other extreme,
it may be possible that the incoming sewage is so
large in volume, and the means for preventing dis-
turbance so inadequate that the entire contents in
the tank are violently agitated and the solids car-
ried through the tank without perceptible diminu-
3968 tion. Between these two extremes are consequent-
ly all manner of degrees of disturbance, so that it
might frequently happen that one tank without
any special devices for preventing disturbance
would, in reality, less injuriously affect the decom-
position of the solids than would another tank
which might be provided with special appliances.

3969 XQ. 104. When and under what circumstances
did you first hear of the Cameron septic tank at
Exeter, England to which you referred in your di-
rect examination? A. My attention was called to
an article in the Engineering News, published
about January, 1898.

XQ. 105. When did it first come to your knowl-

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edge that the Cameron process was patented in the United States? A. I think not until about the year 1900.

XQ. 106. Can you state how the fact of its being patented in the United States came to your attention at that time? A. I do not think I could. I have no definite recollection of what brought the 3971
matter to my attention.

XQ. 107. What did you do upon learning that the Cameron process was patented in the United States? A. From that time I advised clients contemplating the construction of such plants to take legal advice upon the merits of such patent, notably at Lake Forset, Illinois, and other places. 3972

XQ. 108. When did you first obtain a copy of the specification of the Cameron patent in suit? A. I am not certain, but my impression is that it was at or about the time when the City of Lake Forest contemplated building their plant. Probably in 1901.

XQ. 109. Did you obtain this copy at the sug- 3973
gestion of any one else, or merely of your own motion? A. I do not now recall. It is my impression that my former partner, Mr. W. S. Shields, looked into the matter at that time and obtained a copy of the specification which I came to see in our office.

XQ. 110. What was the first mention made by 3974
you of the Cameron septic tank process in your writings or discussions public? A. To the best of my recollection the first notice which I gave to the matter was that containing a report made to the director of public improvements at Columbus, Ohio, dated May 1st, 1898, and found on page 41

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of that report. This was about three months after
the publication of the Engineering News article I
have previously referred to.

XQ. 111. Please read as your next answer all
that you stated about the Cameron septic tank pro-
cess in this Columbus, Ohio, report, of May 1st,
3976 1898? A. I read as follows from pages 41, 42 and
43:

Project No. 55.

The Septic Tank System, With Coke Filtration for the Effluent.

The Septic System of sewage purification is of re-
cent deveopment, and has its origin in Exeter, Eng-
land, where it has been in use for nearly two years.
3977 The first installation covered only one district of
the city, but works are now in progress for extend-
ing it over the entire city. The system has aroused
a very wide interest among sanitary engineers, by
reason of the development of radically different
methods of propagating the nitrifying organism
from those heretofore in use. The Septic system
brings into action what are known as anaerobic
bacteria, so called because they thrive without light
3978 or oxygen, in contradistinction to aerobic bacteria
whose cultivation is now comparatively well un-
derstood. In intermittent filtration, aerobic
bacteria are cultivated in sand beds,
whose stored oxygen is frequently renewed.
Anaerobic bacteria, on the other hand,
requires the sewage to remain for some time
in closed air tight tanks, in order to afford the most
3979 suitable environment for the propagation and ac-
tive work of this form of organism. Covered tanks
are provided, capable of holding the sewage at least
18 hours, during which time active nitrification
takes place, and at Exeter the amount of oxidizable
organic matter in solution is reduced by 38 per
cent., the free ammonia by 26.9 per cent., the albu-
minoid ammonia by 17.5 per cent., and the suspend-
ed solids by 55 per cent., the condition of the re-

maining organic matter rendering it more easily broken up and further purified. The effluent from the septic tank is then passed into a biological coke filter, similar to those described in Project No. 2, for chemical precipitation.

The wide interest which has been taken in this system in England, and the high standing of the chemists who have examined its working and pro- 3981
nounced favorably upon its capabilities, warrants us in considering it in connection with the Columbus problem.

Enough data has been published to enable us to understand in a general way the principles which must govern its use, and general plans have been drawn, estimated and compared with other projects. It will be readily understood, however, that it is impossible to give a new and unfamiliar pro- 3982
cess the same relative standing as should be accorded to older and well understood methods of sewage purification. In laying out this system for Columbus, we have provided 24 hours' rest for the average flow, and 18 hours' rest for the maximum flow. At Exeter the effluent has been passed through coke breeze filters five feet in depth for the remainder of the purification, at the rate of flow of about 660,000 gallons per acre per day. The purification 3983
obtained in the coke filters, at the rate of flow based on oxygen absorbed, is given by Mr. Dibdin in his report at 72.4 per cent. of organic impurity removed. As the sewage of Exeter is shown by the analyses to be about three times as concentrated as the sewage of Columbus, it is thought that this will fully correspond to a purification of 95 per cent. upon the whole plant for this locality.

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In the plan for Columbus, as contemplated, the sewage first passes into an open masonry channel between the tiers of tanks, 32 in number, and capable of holding each 500,000 gallons. Suitable appliances are provided for annually removing the mineral matter which will accumulate at the bottom of the tank, and the gas which may be burned. The overflow from the tanks is then led to artifical coke filter beds similar in all respects to those de-

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scribed in Project No. 2 (Chemical Precipitation), comprising 16 acres of effective area five feet in depth.

One of the most interesting features of the Septic System is the positive determination of the disappearance of the oxidisable organic matter, the sewage in the tanks at Exeter being cleaned of relative-
3986 ly small amounts of mineral residue only about once a year. The minimum time required to fill a tank with this residue has been estimated at three years. It is needless to say that the sludge in so concentrated a sewage as that of Exeter, would create under ordinary circumstances, several times the quantity each year that these figures represent, thus showing the complete disappearance in gaseous forms of the larger portion of the sludge.

3987 From the subjoined estimates it will be found that the first cost of the system is large; and while the running expense is comparatively light, the capitalized cost does not compare very favorably with other methods. It may be remarked that as at Exeter, automatic valves may control the filling and emptying of the filter beds, and thus reduce the running expense. This automatic device is a proprietary article.

3988 The expensive character of the tanks required for this system would seem to argue against its general introduction in the larger cities like Columbus, and especially where the separate system of sewers does not exist. There must be many places, however, where it can be successfully and economically used when conditions are favorable. Certainly it is an addition to the resources of the sanitarian, and will in time no doubt take its place
3989 among the accepted and well tried methods of sewage disposal. (See Plate J for Plan of Project No. 5).

* * * * *

The Septic System, as we have before indicated, is of great interest and unquestioned merit, but we would not at this time feel warranted in recommending its use on so large a scale without great caution, and as it does not appear to be of such low cost as to warrant further consideration, we would set it aside for the purposes of this report.

XQ. 112. Does the article in the Engineering News of January 13, 1898, by which you have stated that the Cameron septic tank process was first brought to your attention contain the following: 3991
"The septic tank system differs from the other new English process in that it attempts to bring an entirely new and different class of bacteria into operation, the anaerobic. These bacteria thrive in the absence of oxygen and are the organisms that give rise to putrefaction. The bacteria whose aid is sought in the other processes including the land treatment of sewage, are aerobic. That is, oxygen, 3992
and plenty of it, is essential to their life processes. They affect, under proper conditions, the decomposition of organic matter and its change to stable forms without any offensive odors?" A. No, sir. I did not recall that that was in the article mentioned. The article I referred to is, however, in the same number of the Engineering News, and is en- 3993
titled, "The Septic Tank System of Sewage Treatment at Exeter, England," on page 18. The quotation which you have made appears to be from the editorial which I did not recall having seen, although I may have done so.

XQ. 113. Does the article to which you refer in the Engineering News, of January 13, 1898, contain 3994
the following: "In conclusion, it may be said that the septic tanks as tried at Exeter, are arousing great interest in England, and that some of the leading scientists of that country seem to be greatly impressed with the work done by the tanks, although no one, so far as we have seen, has yet made

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a careful study of the cost of this system as compared with intermittent filtration?" A. It does.

XQ. 114. In the Columbus, Ohio, report, of May 1st, 1898, to which you have referred, did you submit estimates on seven alternative projects for disposing of the sewage of the City of Columbus,
3996 as follows:

Project No. 1—Broad Irrigation Combined with Intermittent Filtration.

,Project No. 2—Chemical Precipitation Combined with Coke Filtration.

Project No. 3—Chemical Precipitation Combined with Intermittent Land Filtration.

3997 Project No. 4—The Ferozone Polarite Process.

Project No. 5—Septic Tank System with Coke Filtration.

Project No. 6—Coke Filtration, Followed by Land Filtration.

Project No. 7—Double Coke Filtration. A. I did.

XQ. 115. Which of these projects did you in that
3998 report recommended the adoption of by the City of Columbus? A. I recommended the preliminary trial in a limited way, and as an experiment of the double coke intermittent filtration, project, No. 7.

XQ. 116. Does not that Columbus report of yours contain the following: "By a process of exclusion we narrow down to choice to the following propo-
3999 sitions stated in economic order:

Chemical Precipitation with Coke Filtration.

Double Coke Filtration.

Broad Irrigation.

A. It does.

XQ. 117. Since you made that Columbus report down to the present time, how many sewage plants

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have been built by you or under your supervision or according to your designs of each of the seven classes proposed for Columbus, and enumerated in XQ. 114. A. I have not since that time built or designed a plant similar to any one of the classes outlined in that report.

XQ. 118. How many plants have been built by 4001
you since that time, or under your supervision or designs containing a septic tank system combined with filtration? A. As the septic system was understood by me at that time from the publication in the Engineering News, and from the plan and estimate which I submitted at Columbus, I may say
that I have not built any septic tanks in combina- 4002
tion with filtration.

But I have undertaken to design and install tanks for the liquefaction of sewage based upon my own views and a study of the history of the art in a considerable number of cases. Including those which have been designed and not built with
those which have been built, probably twenty-five 4003
to thirty cases.

XQ. 119. Were each of these twenty-five or thirty plants designed by you in such manner as to contain the combination with a filter a preliminary treatment in a tank designed to create the conditions that would accelerate liquefying or anaerobic action? A. A very considerable number of 4004
them are so designed. A smaller number, however, do not have the combination with a filter, and at least are for intermittent filtration alone.

XQ. 120. What feature other than the material of the filter have they lacked to correspond with the septic system as described in that portion of

4005 your Columbus report of May 1st, 1898, quoted in answer to XQ. 111? A. They have all lacked the total exclusion of light and air shown by me in plans for Columbus, which is accomplished there by means of a masonry roof. All of the tanks which I have built or designed since, have been, so far as
4006 I now remember, provided freely with ventilators when covered, windows and doors, and the entire absence of any attempt to exclude the air from outside. At the time of the Columbus design I supposed that the exclusion of light and air was an absolute essential for producing the remarkable results claimed in the Engineering News article, and
4007 accordingly there was very particular to imitate the covering provided for at Exeter as I understood it. The Columbus plan has as especially designed inflow and outflow which I do not recall ever since having imitated, it being believed by me at that time that the anaerobic action was possibly promoted by the peculiarities of inflow and outflow. All of the later tanks which I have designed
4008 or built have used non-disturbing inflows and outflows which were common to the art as I have pointed out in my testimony, and consisted usually of a number of baffle boards disposed throughout the length of the tank. In a number of tanks even these precautions have been omitted.

4009 In the Columbus plan I showed the sewage emptying into one large tank, whereas in all my later plants I used a combination of tanks, the sewage passing from one into the other by means of gates as might be desired. It has been my custom since making the design at Columbus not to cover a number of the tanks, except where being desirous of keeping them from interference I have provided a light wooden building over them for the purpose of preventing malicious mischief and also equalizing the temperature. In this respect my installations very closely resemble the plant at Cheltenham described by Mr. Henry Austin, and the suggested tank described in his report. 4011

It has further been my custom to provide means by which the period of rest within the tank of the sewage might be varied so as to suit the variable conditions. This is accomplished by the combination of compartments to which I have before alluded.

I have never provided means for burning or 4012
otherwise utilizing the gases developed in such tank, nor has it been my endeavor to confine them in any way to the tank as is the case in the Columbus plans.

I have not found my ideas which I had at the time of designing the Columbus plant with reference to the total disappearance of the solids to have 4013
been substantiated and have made my design so as to provide for the frequent removal of sludge when necessary. In this, my designs correspond very close to the tanks described at Cheltenham in England.

In other words, I have found, and that, too, very early, that what I supposed to be an entirely new 4014
process when making my Columbus designs and writing my Columbus report to be as a matter of fact a very old process of decomposition as developed by Henry Austin, Dr. Alexander Mueller, Mouras and Professor Pagliani, abroad, and in this country by Colonel Waring, Phillbrick, Professor Tal-

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bot, Benezette Williams, Mr. MacHarg, and others, in their installations.

I take occasion here to point out my indebtedness to Mr. Cameron for calling my attention to the fact that decomposition and liquefaction as a preliminary stage in sewage purification are as appli-
4016 cable on an enlarged scale as they are upon a small scale, which fact I frankly admit I did not perceive prior to the publication of his work at Exeter.

> Answer objected to as totally irresponsive, and the attention of the Court is particularly called to it as best evidence of the intense bias of this witness and his
> 4017 disposition to introduce argument for the purpose of subserving his interests.

XQ. 121. In order to avoid such long discussion as to differences which we probably could not agree as to the materiality of, and at the same time to get in a concise form before the Court the actual construction and operation of the tanks that you have
4018 been building or designing since your Columbus report of May 1st, 1898, I will ask you whether the construction and operation of your said tanks is shown in your patent, No. 770,490, of September 20, 1904, applied for July 13, 1901, and if so, which of the figures of said patent show substantially tanks actually installed by you, or under your su-
4019 pervision? A. The figures of the patent do not show even substantially a resemblance to the plants I have constructed with the exception that Figure 1 gives a fair idea of the division of a tank, such as I have constructed, into compartments. I have, however, never carried out the system of diversion shown in that figure, but have accom-

plished substantially the same result by means of weirs and baffle boards.

I have designed no tank corresponding to figures 5, 6, 7 and 8, 9, 10, 11 or 12.

XQ. 122. Does that patent, No. 770,490, correctly describe the operation of the tanks installed by you since the Columbus report of 1898, as fol- 4021
lows: "This invention relates to a novel process of purifying sewage by septic action, wherein the raw sewage with or without previous treatment, is slowly passed through a tank or tanks of relatively large area in which such conditions or environments are established and maintained as to develope enormous numbers of bacteria known as 4022
'anaerobic' bacteria, or bacteria which thrive without free oxygen, said bacteria, in a manner not at present well understood, acting upon the solid matter held in suspension in the sewage and reducing the same to a gaseous or liquid form, whereby the effluent discharged from the tank consists of a relatively clear and inoffensive liquid. This effluent 4023
may be diverted at once to natural waterways or may be further purified by being subjected to a secondary treatment which consists in passing the effluent over or through contact beds consisting of coke breeze or similar substances? A. The figures of the patent do not show even substantially a resemblance to the plants I have constructed with 4024
the exception that Figue 1 gives a fair idea of the division of a tank, such as I have constructed, into compartments. I have, however, never carried out the system of diversion shown in that figure, but have accomplished substantially the same result by means of weirs and baffle boards.

I have designed no tank corresponding to Figures 5, 6, 7 and 8, 9, 10, 11 or 12.

XQ. 122. Does that patent, No. 770,490, correctly describe the operation of the tanks installed by you since the Columbus report of 1898, as follows: "This invention relates to a novel process of puri-
4026 fying sewage by septic action, wherein the raw sewage with or without previous treatment, is slowly passed through a tank or tanks of relatively large area in which such conditions or environments are established and maintained as to develope enormous numbers of bacteria known as 'anaerobic' bacteria, or bacteria which thrive without free oxygen,
4027 said bacteria, in a manner not at present well understood, acting upon the solid matter held in suspension in the sewage and reducing the same to a gaseous or liquid form, whereby the effluent discharged from the tank consists of a relatively clear and inoffensive liquid. This effluent may be diverted at once to natural waterways or may be further purified by being subjected to a secondary treat-
4028 ment which consists in passing the effluent over or through contact-beds consisting of coke-breeze or similar substances?" A. I should say it does.

XQ. 123. Can you refer me to any publication, showing the construction and operation of any of the plants which you have installed since the Columbus report of 1898? A. You will find in a
4029 paper read by me before the Western Society of Engineers, February 5, 1902, and published in their Journal, April, 1902, a paper entitled, "Sewage Purification Plants," in which there is a description of a number of plants which I have either designed or built. The paper is accompanied by illustrations and cuts.

It is stipulated and agreed by and between counsel that the issue of the Journal of the Western Society of Engineers of April, 1902, Vol. 7, No. 2, pages 113 to 144 may be referred to in the evidence and arguments of this case with the same force and effect as though introduced in 4031
evidence as an exhibit.

XQ. 124. On page 141 of the article referred to in your last answer is shown the distribution of septic tank effluent upon intermittent filtration beds at Wauwatosa, Wisconsin. In how many of the plants installed by you since the Columbus report of 1898 was the septic tank effluent distributed upon filtra- 4032
tion beds and in how many was it not? A. About one-third of the plants which I have installed are arranged so as to distribute the effluent upon filter beds.

XQ. 125. And how is the effluent disposed of in the other two-thirds? A. In the majority of them it empties into a flowing stream. 4033

XQ. 126. How many of them have you installed altogether inclusive of the two-thirds and the one-third? A. I should say probably sixteen or eighteen plants have been actually built from my designs.

XQ. 127. Can you give an idea as to the number of population that those plants dispose of the sew- 4034
age from altogether? A. Not accurately without a careful detailed review, but speaking generally, I should say the plants in operation serve perhaps twelve to eighteen thousand people.

Complainant's counsel offers in evidence a printed Patent Office copy of U.

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S. patent, No. 770,490, to the witness, J. W. Alvord, dated September 20, 1904, for Process of Purifying Sewage, and the same is marked Complainant's Exhibit, Alvord Patent.

XQ. 128. In the specification of your patent, No.
4036 770,490, you state as follows:

"It is requisite, therefore, to the proper treatment of sewage by bacterial action that environments be established and maintained in the septic tank which are favorable to the active and continued propagation of the bacteria, and to the prolongation of life of existing organism for the reason that if conditions be set up which retard
4037 propagation and shorten the life of the bacteria (which occurs when the rest period is unduly prolonged) a state of decomposition in the sewage is set up which results in a deteriorated effluent. On the other hand, an insufficient rest period produces little or no change in the effluent, with the exception that said effluent is subject to rapid decomposition when exposed to the air. Moreover, variations in the volume of the sewage vary the flow through the receptacles in which the septic
4038 action takes place, and it is essential that these variations be counteracted by varying the capacity of the tank or tanks so as to produce a uniform rest period for varying volumes of sewage. My improved process consists, therefore, of passing the sewage to be treated through a receptacle or receptacles and varying the rate of flow through the tank with respect to the characteristics or vol-
4039 ume of the sewage and to thereby vary the period of time during which the sewage is subject to the septic action to correspond with the known or determined rest period required for the proper purification of different kinds of classes of sewage."

As I understand it, in carrying out the process of your patent above referred to, the size of the tank will depend upon the quantity and character of the sewage to be treated. Is this correct? A. That was essentially the idea I had in mind.

XQ. 129. Was that essentially the idea you had in mind in desiguing the septic tanks that you have built since 1898, as well as in designing the tanks shown in your patent referred to? A. No, not altogether. The idea contained in the 4041
patent which you have quoted grew upon me from study of tanks which I built prior to 1902, and the idea attained its maximum prominence in my mind in the year 1902. I am not sure now that I know so much about the regulation of sewage in tanks as I thought I did in 1902.

XQ. 130. And the idea embodied in the 4042
operation described in your patent and existing in the various septic tank plants built by you since the Columbus report of 1898 has been that the decomposition of the sewage should be accelarated by the use of the septic tank properly designed before subjecting the sewage to the nitrifying bac- 4043
teria in contradistinction to the idea of bringing the sewage in its fresh stage and before decomposition sets in into contact with such nitrifying bacteria. Is that so? A. That does not describe the idea which I have had, and I may explain that it has been my idea to dissolve the solids of sewage by decomposition as far as possible, and 4044
yet not retain the liquids of the sewage so long within the liquefying tank that they are not readily filtered. I am not now clear at all as to where the process of nitrification begins and where the process of liquefaction ends, or whether they do not proceed conjointly under certain conditions.

I think in some of my earlier writings I have used the word "nitrification" rather loosely, and this is due to the fact that the Massachusetts State Board of Health had so fully investigated this part of the subject that they gave the impression that the whole process of sewage purification
4046 was largely due to nitrification, whereas it has been clearly pointed out by earlier authorities that the dissolving of solids is largely due to anaerobic action.

XQ. 131. As I understand you, the idea embodied in the operation described in your patent and existing in the various septic tank plants in
4047 which the septic effluent was distributed upon nitrifying filter beds built by you since the Columbus report of 1898 has been to dissolve the solids of sewage by decomposition as far as possible, and yet not retain the liquid of the sewage so long within the liquefying tank that they are not readily filtered. Is that so? A. That is a
4048 fair statement of my idea except that I would not be willing to accurately define the final stage as nitrifying. It is my belief that liquefaction is accomplished, to some extent, upon the filters in ordinary practice.

XQ. 132. What then would you designate the final stage in the filters to be if not nitrifying?
4049 A. I might be willing to say that it is mainly nitrifying, but in most filters which I have observed, especially those receiving the effluent from septic tanks there is a large amount of liquefying action which is being completed in the finer particles of suspended matter that come over with the effluent. I have never been able to elim-

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inate this action entirely, although it has been my aim to do so in the regulation which you have quoted from my patent, and while I find such regulation very beneficial I have not succeeded in making it absolute to the exclusion of all liquefaction among the filters so far as I have gone.

XQ. 133. Before your mention of the Cameron 4051
septic tank process in your Columbus report, can you point out a single passage in the publications of any of your discussions or writings wherein you stated that decomposition of the sewage was desirable as a preliminary to the action upon it of nitrifying or aerobic bacteria, whether such aerobic bacteria were supplied in a filter or in 4052
diluting water? A. I do not recall that prior to the publication of the 1898 report at Columbus that I ever discussed the theory of sewage purification in any publication at all.

XQ. 134. Did you not in January, 1898, deliver a paper on the purification of sewage which is published in the Thirteenth Annual Report of the Illinois Society of Engineers and Surveyors and 4053
which paper commenced as follows:

"In the growing interest and attention which the subject of sewage disposal is now receiving in this country a large share of attention is being given to land methods. It may be said that intermittent filtration is the sanitary fad of the hour. Perhaps it deserves the attention it receives, but it must not be overlooked that for localities where 4054
land is not available at reasonable cost, where the quantity of sewage is large and where dilution is partially available for clarified effluents, the chemical method of sewage purification may become a sturdy rival for favor, and will probably outstrip in economy and efficiency from a practical point of view a more popular rival.

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If then the sanitary expert comes to a problem where conditions exist favorable to chemical disposal it behooves him to confront the problem without prejudice and with a clear comprehension of the possibilities and advantages of that method of purification."

A. The paper from which you have quoted was
4056 read by me in January, 1898, and is essentially a description of certain works at Acton, England, which I had visited.

The immediate cause of its publication was the fact that the City of Madison, Wisconsin, had just contracted for a plant upon that process, and as I had visited Acton and observed its workings
4057 ten years before I thought an account of them would be interesting.

The introductory remarks from which you have just quoted are intended to lead up to a description of a chemical precipitation plant and could hardly be designated as a serious discussion of the theory of sewage purification.

4058 XQ. 135. Do you also find that in the Eleventh Annual Report of the Illinois Society of Engineers and Surveyors, 1896, you are reported as having participated in the discussion of sewage irrigation, and as having stated, among other things: "In England, where they have carried this thing much farther than we have, there have been notable at-
4059 tempts to utilize the sewage of towns upon farms by broad irrigation or use of sub-irrigation and by the application of chemicals, but so far as he knew, with possibly one or two exceptions they had not succeeded?" A. The discussion in question, you have quoted, followed a paper read before the society by Mr. Walter C. Parmley, entitled "Sewage

Irrigation for Profit," and the paper was entirely devoted to the elements which might make for the financial success of sewage farming.

In refering, therefore, to the quotation you have made, it will be seen that the term, "they had not succeeded," refers to the financial side of the problem. 4061

I do not find in the discussion anything which would appear to me to be a discussion of the theory of sewage purification.

XQ. 136. I now ask you to answer yes or no XQ. 133 which is as follows: "Before your mention of the Cameron septic tank process in your Columbus report of May, 1898, can you point out 4062
a single passage in the publications of any of your discussions or writings wherein you stated that decomposition of sewage was desirable as a preliminary to the action upon it of nitrifying or aerobic bacteria whether such bacteria were supplied in a filter or in diluting water?" A. I cannot point out any such statements in any of 4063
my writings prior to May 1st, 1898, for the simple reason that I never discussed the subject in any publication.

XQ. 137. In your Columbus report of May, 1898, before your mention of the Cameron septic tank process did you, under the heading "The Purification of Sewage" state on pages 10 and 11 4064
as follows:

"The best known names in the field of sewage disposal methods are 'Broad Irrigation,' 'Intermittent Filtration,' 'Chemical Precipitation,' and 'Dilution,' but the distinction between them in principle is not so great as the mere name would indicate. . . . .

4065 In making an application of these methods to the local conditions of the City of Columbus, it will be observed that in nearly every case combinations are preferred, rather than the simple form above defined; but this is only another illustration of the indefiniteness of any single name to convey an idea of the principles to be applied.
4066 Those principles may be briefly stated as follows: The sewage in its fresh state before decomposition has set in must be brought into contact with wide diffusion at innumerable points, with certain forms of nitrifying bacteria in the presence of a sufficient supply of oxygen, and retained under the conditions a proper length of time for complete chemical change to be accomplished. This properly done, the sewage is found to be purified without offense or odor, and without danger to
4067 human health in any way.

A. I did, and the definition seems to me to be complete and clear as I understood the principles at that time.

XQ. 138. And immediately following the quotation of my last question under "The Experience of Other Cities" did you in the same report,
4068 on pages 12, 13 and 14, enumerate twenty-one cities in this country and in Europe and give the method of sewage disposal in use by each? A. I did.

Adjourned till Monday, September 18, 1905, at 10 o'clock A. M.

4069 Monday, September 18, 1905; met pursuant to adjournment; present as before except Mr. Gifford.

Cross-Examination of Mr. Alvord Continued by Mr. Fisher.

XQ. 139. Referring to the statement made in your Columbus report of May, 1898 (p. 11) and

quoted in XQ. 137 that "The sewage in its fresh
state before decomposition has set in must be
brought into contact at innumerable points, with
certain form of nitrifying bacteria in the presence
of a sufficient supply of oxygen, and retained
under the conditions a proper length of
time for complete chemical change to be ac- 4071
complished," will you please state from what
sources prior to the Cameron invention you derived
the information upon which this quoted
statement was based? A. I see traces in this
statement of my prior studies of the Massachusetts
State Board of Health perhaps more than
any other one source of information. As I have 4072
stated before, the Massachusetts State Board of
Health devoted their attention very largely to
studies of intermittent filtration upon sandy soil
as a method of sewage purification. These studies
led them to adopt the method of delivering the
sewage, both liquid and solids, upon a bed of prepared
sand well underdrained, and by means of 4073
which the solids were retained upon the surface
of the filter until dissolved while the liquids percolated
through the sand and were purified. The
reports of the Massachusetts State Board of
Health devoted a great deal of attention to the
subject of nitrification, and as I have before mentioned
it was even at one time supposed that a 4074
specific form of nitrifying bacteria had been isolated
and studied.

I see evidences all through my Columbus report of the influence of these studies in a somewhat too broad use of the term nitrification by which it appears to me now I must have more exactly meant dissolution by micro-organism. For instance, on page 41, in the quotation which I have before made with reference to the septic tank system, I say:

"The system has aroused a very wide interest among sanitary engineers by reason of the devel-
4076 opment of radically different methods of propagating the nitrifying organisms from those heretofore in use."

This appears to me to have been an improper use of the word nitrifying as is shown by my more exact description of the anaerobic bacteria later. Immediately below this first quotation I say:

4077 "Covered tanks are provided capable of holding the sewage at least 18 hours during which time active nitrification takes place."

It is evident from this quotation also that I was accustomed at that time to use the word "nitrification" where the word dissolution or reduction would have been a more proper term.

4078 A further instance of the unfortunate use of the word "nitrification" occurs on page 36 where I say, in speaking of coke breeze filters:

"Sufficient to say that a filter constructed and operated as above described is a true biological filter favorable to the growth and propagation of that form of nitrifying organisms the presence of which is essential to the oxidation of the organic
4079 matter."

This again seems to be an unjustified use of the word "nitrifying" where its absence left the language more exact.

I, therefore, trace through the somewhat too frequent and careless use of this word "nitrifying" the influence of the Massachusetts State

Board of Health reports upon my mind, and as I have before stated it is my belief that the studies of the Massachusetts State Board of Health, devoting as they largely did their attention to one phase of the subject and coming at a time when there was a revival of interest in the whole problem largely influenced many sani- 4081
tarians to neglect the earlier works of Colonel Waring, and his imitators in their studies of the preliminary stages of sewage disposal.

In making the statement that "the sewage in its fresh stage before decomposition has set in, must be brought," etc., I see clearly traces of my careful reading of the works of Colonel War- 4082
ing who always and everywhere carefully enunciated the principle that sewage must be purified by means which are put into operation before decomposition had set in, that is to say, that the sewage must be brought to the plant in a comparatively fresh state. This was urged by him in support of his separate system of 4083
sewers which he introduced into this country, and which were designed by him for this purpose. In other words it was his idea that liquefaction, decomposition or dissolution of the solids of sewage ought not to take place immediately in and about the premises where they were created, but should be conveyed as rapidly as 4084
possible to some point as remote as might be, where the dissolution and purification could be accomplished in safety and without offense.

That I was not limited in my conception by what I now consider to be a careless use of the word "nitrify" is shown by the further quotation from the same report on page 9, under the heading "The Purification of Sewage," I quote as follows:

"Sewage may be defined as water contaminated with the wastes of life. These wastes are composed of complex and unstable chemical com-
4086 pounds which are resolved by the process of nature into more simple and harmless forms, mineral and gaseous. The operation as now understood is accomplished by innumerable swarms of bacteria operating generally in the presence of a sufficient supply of oxygen."

I call particular attention to the significant use of the word "generally" at this point:

4087 "And is everywhere taking place under our eyes in nature. The operation becomes obnoxious and dangerous only when unduly concentrated as is the case in malarious swamps, decomposing bodies of animals, or the results of thickly inhabited populated centers. Under such circumstances the want of oxygen in sufficient quantities, and other proper and suitable conditions for the growth of certain necessary forms of bacteria not only allows offensive and unhealthy gases to be created but danger-
4088 ous forms of bacteria are propagated which, if allowed to seize upon living tissue, become fatal to human life.

There is theoretically but one system of purifying the sewage which a large community will create, and that is to so arrange disposition of those waters that the process which nature intends for this purpose, and provides when permitted, with
4089 boundless prodigality, shall have the fullest possible scope of action unhampered and unhindered.

To this end all sanitary science is directed and along these lines all sanitary success has been won.

The various methods by which nature is thus allowed, and in some cases assited to do her work, are very large in number and shade into each other in great variety. Their differences as to principle when properly conceived are generally slight, while in detail they may vary greatly. There is no general form which can be said to be the best method of purifying sewage, but each locality presents its local problem which cannot be met by a sovereign specific."

The above description of the theory of sewage purification seems to me to be a fair statement of what was in my mind at that time, but 4091
there is no doubt whatever, in my mind, as I have elsewhere stated, that at that time I was more largely dominated by the ideas advanced by the Massachusetts State Board of Health in their researches than I was by the macerating tank of Colonel Waring, and it was not until the public experiments of Mr. Cameron's work at 4092
Exeter had been studied by me for some months that I began to perceive the importance of Colonel Waring's work in that it could be applied on a larger scale than had previously been thought possible, or that even he himself had fully conceived.

XQ. 140. Did you, in the Engineering Record 4093
of March 16, 1901, make the following published statement:

"There is a general rush just at the present time to introduce the septic tank into sewage purification works, new and old. It seems to be the general impression that anything that will hold water no matter what its form or whether the flow required a rest period of 20 minutes or 36 hours, 4094
closed or open, shallow or deep, new or old, will answer for a septic tank and will in some miraculous way purify all kinds of sewage of any strength, temperature or variation of quantity, with facility, neatness and despatch. . . . . .
Then, too, it is found from experience, that the form of tank has a great deal to do with its efficiency. It is only too evident that in some forms of

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tanks inadequate filling apparatus allows the sewage to seek a direct path from inflow to outflow, thus converting a tank of great theoretical capacity into one of very short rest period, practically. Again, the bacteria being found most abundantly upon the scum of the surface and the sludge at the bottom, it is evident that the aera provided for
4096 them has a relation to the capacity or effectiveness of the tank."

A. The quotations are correct and the article in question was caused very largely by what I consider the very broad claims of Mr. Cameron in his experimental work and the disposition of the public, which I regarded at the time unfortunate, to accept without question these claims.

4097 XQ. 141. Have you not in your various publications and elsewhere emphasized the fact that a septic tank to be practical and successful as such must be carefully designed with regard to the character and volume of the sewage for the disposal of which such tank was to be used? A. I think this would be a fair statement of my po-
4098 sition if the word "proportion" instead of "design" should be used. I think I may say that I have rather persistently advocated care in the proportioning of such tanks to the conditions which they were expected to meet.

XQ. 142. And have you not also, in your various publications, repeatedly called attention to
4099 the fact that in order to be successful, septic tanks should not be left alone but should receive attention? A. I have.

XQ. 143. State why it is that you regard the careful proportioning of a septic tank and attention to its action essential to its successful operation? A. I have observed that effluents from

such tanks that are not, in my opinion, properly proportioned, either are very difficult to properly filter, as is the case when the liquid is retained too long in the tank or contains too large an amount of suspended matter, as is the case when the tank is small in proportion to the flow;
and it has seemed to me from such study that 4101
there was a desirable mean between these two extremes which could be obtained by proper adjustment and intelligent control.

XQ. 144. What do you consider as the essential points for successful operation to be borne in mind in determining the proportion and de-
sign of a septic tank? A. The amount and char- 4102
acter of the solids in sewage, the volume of flow, the temperature at which the sewage may be maintained would seem to me all to have bearing on the question.

So far as my studies have gone the retention of the sewage in the state of relative rest, and
the attention, so far as possible, of the chemical 4103
heat evolved from dissolution which is going on, are the most important requisites. To bring the sewage into a state of comparative rest, it is desirable that it should be diffused throughout the tank by means of baffles or other adjuncts which will keep it in a state of rest.

XQ. 145. Is the following a correct quotation 4104
from a pamphlet published by you in April, 1903:

"It is coming to be seen that in large plants skilled operation is vitally necessary, fully as necessary as intelligent design and construction, and must be counted on in advance. . . . . .

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SEPTIC TANK.

As an illustration of this, take for instance the care of the septic tank. It is assumed for the most part, that the septic tank once installed needs no particular supervision; that it operates wholly without attention, save perhaps a yearly cleaning. Now, it has been well demonstrated that this is not
4106 true; that the septic process is like all sewage processes a sensitive and delicate process, ameanable to control and subject to natural fluctuation, which must be watched and governed if the best results are to be expected. The particular function of a septic tank is to break down the suspended matter to a manageable state, either by resolving it partially into gases and finely divided sediment, or, if possible, wholly into impurities in solution. That
4107 this latter result can more or less be attained by properly designed tanks carefully operated has already been fully demonstrated. . . . . . .
A septic tank whose effluent shows advanced decomposition is plainly too large for the quantity then happening to flow through it, and the best results cannot be expected or obtained in the further or secondary treatment of the impurities. On the other hand an effluent from the septic tank con-
4108 taining large quanities of suspended matter suggests that there is not a proper length of fermentation period to break down the suspended particles, and that additional fermentation period is necessary. . . . .

The proper regulation of the septic tank is of great importance, not only because it produces high efficiency for the tank itself, but because it also enables the secondary stages to be operated with
4109 equally high efficiency."

A. The paper in question was read by me before the American Society of Municipal Improvements, at Rochester, New York, April 23rd, 1903, and was entitled "The Practical Operation of Sewage Purification Plants," and the quotations are correct.

XQ. 146. What particular forms of tanks did you have in mind when you stated in the Engineering Record of March 16, 1901, that "It is only too evident that in some forms of tank inadequate filling apparatus allows the sewage to seek a direct path from inflow to outflow, thus converting a tank of great theoretical capacity 4111
into one of very short rest period practically?" A. I think I had in mind tanks of the type described by me in relating the experiments with fluroscene, that is to say, deep circular tanks with inlet and outlet relatively close together and without the baffle wall, such as is shown in the cut of Flush-Tank Company's catalogue, page 24, for 4112
instance. Also rectangular tanks which might be excessively broad in proportion to their length and unprovided with baffle walls or plates.

XQ. 147. What do you mean by the expression "Thus converting a tank of great theoretical capacity into one of very short rest period, practically," occurring in the above quotation? 4113
A. A tank which would have a large cubic content in proportion to the inflow, perhaps, but through defective shape or absence of baffle walls, one which might permit the solids to escape before being dissolved by reason of the directness from the inflow to the outflow. Such a tank might not have diffusion of the sewage throughout its 4114
total content in such a manner as would make it most effective.

XQ. 148. In contradictinction to the forms of tanks referred to in your answer to X. Q. 146, what do you understand to be the general. characteristics of a properly proportioned tank, or a

4115 tank of proper form for successful septic operation? A. So far as my studies have gone, I have become favorably disposed to tanks of great length with relatively small cross section, but inasmuch as it is not often convenient or economical to construct such a tank in one straight sec-
4116 tion I have often arranged to obtain practically the same result by dividing an ordinary rectangular tank whose length was perhaps two or three times its width into compartments through which the sewage might traverse a path with practically the same results as in the ideal tank I have mentioned.

4117 A large number of the tanks I have thus designed rather closely resemble the tanks in the Ealing sewage works in England, shown in Santo Crimp's book, page 14, opposite page 158, and marked "Subsiding Tank No. 1" and "Subsiding Tank No. 2."

XQ. 149. And in designing what you have des-
4118 ignated as a properly proportioned tank you would have the distance from the inflow to the outflow at least greater than the width of the tank, would you not? A. I would if possible, although I do not believe that this is always an absolutely necessary requirement.

XQ. 150. In designing a septic tank which
4119 you would regard as properly proportioned for successful septic operation, would you not have in mind and determine the form and proportions of such tank by the following, viz: (1) Absence of Agitation; (2) Bodily Slowly Flowing Current; (3) Exclusion of Light and Air Either by the Scum or by a Cover; (4) The Relation of the

Size to the Quality of Sewage; (5) The Relation of the Size to the Quality of Inflow, and (6) Such Disposition of Inlet and Outlet as Would Enable the Bacteria to Effectively Liquefy the Solid Organic Matter of the Sewage? A. I do not think I would take the same order that you have observed or include as essentials some of those you 4121
have mentioned. If asked specifically as to what order and essentials I would mention the following: (1) Absence of Agitation, by which I would mean not that the sewage was brought to complete rest, but that it was caused to flow in a quiet manner, such as would be produced by entry into a tank or might even be caused by its flow 4122
through a sewer somewhat larger than would be necessary to convey it.

Second, I would place as most important Means for the Retention of the Chemical Heat, so that it would not be lost or dissipated, and that the sewage would be kept at as relatively high a temperature as possible, not, however, much exceed- 4123
ing 80 or 85 degrees Fahrenheit. This requirement I regard as especially important for the active propagation and activity of the bacteria.

Third, I would place Desirability of Constant Addition of Liquid and Constant Abstraction of Liquid from the Body of the Sewage in which the bacteria are being generated. I am at the present 4124
time of the opinion that this is desirable so that the wastes of bacterial energy may be removed and the activity of the bacteria themselves be not vitiated by their own poisons. I would observe, however, that the absence of this provision would not necessarily destroy bacterial activity, but only retard it.

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Fourth, I would place Regulation of the Retention of the Liquid Portion in the Sewage Within the Tank. I am of the opinion that it is desirable to abstract the liquid of the tank as rapidly as it can be freed from the solids or suspended matter of the sewage, as I have observed that
4126 such liquid is the most readily filtered when it has been comparatively a short time within the tank.

I do not attach at the present time any value to the absence of light or air, although I am accustomed to believe that the presence of scum is a good indication of proper operation. Still I
4127 have observed tanks in which liquefaction was rapidly proceeding which were unprovided with a cover and not covered with scum.

I do not set store about the adjuncts which may be provided for the inlet and outlet unless it is observable that without such adjuncts agitation of the sewage within the tank results. In
4128 the tanks of great length, such as I have suggested I prefer, the kind or variety of inlet and outlet are relatively unimportant, as agitation is prevented from seriously interfering with bacterial action by the great length of the tank.

In rectangular tanks where inflow and outflow create commotion within the tank I should be-
4129 lieve that baffle boards such as I have shown are commonly in the history of the art would be desirable.

I do not believe that disposition of inlet and outlet are governing factors in enabling the bacteria to effectively liquefy the solid organic matter of the sewage. I hold the view that the sol-

ids of sewage are liquefying and decaying from the time of their production and continue to so liquefy and decay until they disappear, consequently I do not regard tanks, baffle boards, especially devised inflows or outflows, of vital significance in the process of organic dissolution. I
only feel that with their proper arrangement and 4131
correct proportioning the processes of nature are accelerated rather than retarded. I have rarely, if ever, seen a plant for the dissolution of the solids in sewage in which I did not think there was some slight reduction going on, and as I have said before, nothing in my opinion can stop this action
except the addition of antiseptic chemicals or the 4132
sterilization of the sewage by a high degree of heat. Therefore, in a tank which I would regard as properly proportioned for successful septic operation I would regard the first two essentials which I have mentioned as of very great importance, and the second to the sixth essentials men-
tioned by you in your question as of relatively 4133
small importance, and while I might adopt them and probably would adopt them in the present state of my knowledge I should regard it possible to dispense with either or perhaps all of them under certain conditions.

XQ. 151. In the paper which you read before
the Western Society of Engineers, in April, 1902, 4134
did you not state the following:

"The septic tank in good working condition, and which is not being overcrowded, should have from four to eight inches of thick scum over its entire surface."

A. I did and as I have said in my last answer, "I am accustomed to believe that the presence of scum is a good indication of the proper operation. Still I have observed tanks in which liquefaction was rapidly proceeding which were unprovided with a cover and not covered with scum."

It is usually found, however, that the septic
4136 tanks caring for a normal sewage and properly proportioned will show a scum about as described in the quotation you have made from my article.

XQ. 152. To what did you attribute the absence of scum in the tanks in which you have said such absence was observable? A. It seemed to me that the sewage was not normal in that
4137 there was an absence of solid matter of a lighter specific gravity than the water.

XQ. 153. But your observation has been that with the sewage of normal character a scum of from four to eight inches would cover the surface. Is that correct? A. Yes, sir.

XQ. 154. If you were called upon to determine
4138 whether or not a sewage disposal tank were operating properly or successfully as a septic tank what steps in the examination of such tank would you take, or what data with respect to its operation would you require? A. If by "examination" you mean a physical examination only, I would desire to draw a sample of the effluent from
4139 the tank in a bottle and closely observe the amount of finely suspended matter which it contained. Also I should observe whether large lumps of solids were coming out with the effluent which I should take to be an indication of defective arrangement of the plant.

If the effluent were very clear in the bottle I

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have mentioned, I should seal it and leave it sealed for several days and observe whether black flakes formed in it which would be an indication to me that there was considerable reduction of impurities still going on.

I should closely observe the inflow to the tank
if possible to see whether the raw sewage was 4141
concentrated, dilute or normal. If access could be had to the tank I should take occasion to stir the scum with a stick and observe if gas bubbles were produced copiously, and if I found such gas bubbles produced copiously I should take it as an indication that bacterial action was active.

If possible I should measure the thickness of 4142
the scum on the top of the liquid and the depth of the sludge at the bottom. If there were no scum and nevertheless the liquid gave evidences of numerous gas bubbles I should still take it that bacterial action was going on with fair rapidity. The thickness of the top scum and the
bottom deposit would only have a meaning in 4143
connection with the production of gas, for if no gas is being produced and the top scum were very thick and the bottom sludge very heavy, and the effluent filled with floating solids I should judge that the activity of the tank was low. If, on the other hand, the inflowing sewage was normal or
concentrated the production of gas on stirring 4144
the scum abundant, and if the effluent from the tank was quite clear and produced no black flecks on standing sealed for several days I should regard the tank as doing excellent work, especially if it had been in service any great length of time.

4145 I have seen an effluent from the Champaign tank which, when kept in closely stoppered bottle for several days, gave no odor on opening it, as well as produced no black fleck. This I regarded as the best result which ever came under my observation, a result which I am free to say
4146 I never succeeded in equalling in any of my own tanks.

XQ. 155. Did you observe a tank intended for septic operation and seemingly properly proportioned in which the septic action was not proceeding successfully? A. I don't recall that I ever have.

4147 XQ. 156. Do you mean to be understood by your last answer as indicating that all septic tanks that have come under your observation have been practically successful? A. No, sir, but where there have been conspicuous failures it has always seemed to me that I could see some reason for it. I may have been wrong in finding that
4148 reason at times, but I have always been able to assign to the satisfaction of my own mind, at least, some intelligible belief for the failure. Some cases of failure which have come under my observation seem to me to have occurred through the growth of the amount of sewage that the plant was receiving beyond the capacity for which
4149 it was apparently designed. This growth has generally been the natural growth of the city, the addition of new sewer connections, the spread of population and the increase of the water supply. In some cases I have observed tanks which fail to give a good effluent because they were designed to care for the future population of the city while

the present needs and requirements did not begin to utilize their capabilities.

XQ. 157. Do you recall any other reason for failure of septic tanks that have come under your observation besides the reasons given in your last answer? A. No, sir, most of the failures which
I have observed seem to me to have come from a 4151
disproportion between the capacity of the tank and the quantity of incoming sewage, and it seems to me that it must be said that these are proportional failures only because, as I have before observed, I do not think that the dissolving action ever entirely ceases, but that it is relatively
greater under some conditions than others. 4152

Of course when a tank is receiving solids faster than it can digest them, and as the solids begin to accumulate this very accumulation further reduces the liquid contents of the tank and its capacity for receiving further solids, so that the deterioration in capacity once commenced will go
on with increasing rapidity until at times the en- 4153
tire tank may become nearly filled with solids which are dissolving so slowly as to not keep pace with the accretions from the inflow.

I recall one instance of a failure of the tank from extraneous conditions which resulted from the emptying into the tank of a large quantity of
calcium hydrate, or the residue from acetylene 4154
gas tanks. This, however, was accidental and unusual, and aside from this instance I recall no other which did not seem to me to proceed from a disproportion of the incoming solids to the liquid contents of the tank.

XQ. 158. Have you not observed defects in the

operation of septic tanks, which defects you attributed to improper size of the tanks, with respect to the volume of sewage delivered thereto? A. Yes, sir, I have observed what I consider to be defects in the design and construction of tanks which have resulted in not the most effective op-
4156 eration, and which were attributable to other causes than those mentioned.

I am of the opinion that deep circular tanks without dividing baffle wall are not such effective tanks for relatively large flows as very long tanks of comparatively small transverse area. I would not, for instance, consider the tank at St. Bede's
4157 College as effective a design as though it had been a long tank with a cross section of not more than 15 square feet. I think it would have been desirable, for instance, in that tank if there had been a baffle wall across the inlet pipe as well as the outlet pipe and a central baffle wall across the tank such as are designated in the cut on page 24
4158 of Flush Tank Company's catalogue.

Still I would not say that these are more than minor defects. Certainly their absence does not retard the liquefying action to any serious extent unless the inflow becomes so great as to churn up the entire solid contents of the tank and cause it to escape from the outlet in spite of the
4159 baffle wall.

XQ. 159. In the course of your cross-examination a day or two ago you were requested to give a list of all the installations of tanks of the type shown in the Flush-Tank Company catalogue. Will you now give that list? A. I have a clerk in my office at work going through my memo-

randa with a view to giving a list of this kind, and he has already brought to my attention three plants which I could not recall the other day. One of these was situated at the northwest corner of Belmont Avenue and Lake Shore Drive in Lake View, and was in use and observed by me
about the year 1886 or 1887, at the residence of 4161
Mr. Chase. This plant consisted of a tank only without the subsequent filtration and was discontinued about the year 1886 or 1887 at the time I was constructing a sewer system in that vicinity. The matter was brought to my recollection because Mr. Chase showed me his tank at the time and explained to me its working. 4162

Other installations I recall seeing at the residence of Mr. Cyrus H. McCormick, at Lake Forest, on or about the year 1898 or 1899; also at the residence of Mr. Swift west of the track in Lake Forest, although I think this is a comparatively recent installation. I also recall C. B. Farwell
having an installation of this kind at Lake For- 4163
est before I installed the sewer system there in 1888 or 1889. Although I do not now recall very fully this latter installation except to remember that it was discontinued upon the completion of the sewer.

I was also asked in prior questions if the in-
stallation at Blair Lodge and the residence of Mr. 4164
Byron L. Smith was still in operation, to which I replied that I was not able to say I have since been able to recall from the investigation now going on in my office that both of these installations were discontinued at the time of the completion of the north end sewer system about 1902,

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that at Blair Lodge having been connected by us into the main sewer at the time of the building of the sewage purification plant about 1902.

Adjourned till tomorrow, Tuesday, September 18, 1905, at 10 o'clock A. M.

4166 Tuesday, Sept. 19, 1905, ten o'clock A. M.; met pursuant to adjournment; present as before.

XQ. 160. Are you able to state the constructions of the several flush tanks referred to in your last answer and to state wherein they differed one from the other, if they differed at all? A. I am not able to give a description of these plants in detail as my
4167 observation of them was limited to a surface inspection, and general information that they were plants intended for the putrification of sewage, and I was able to recognize from that description their identity with the Waring system.

In the case of Mr. Chase's plant before alluded to, I recall, however, seeing the interior of the tank
4168 which had baffle inlet and outlet and which was the macerating tank proper.

My attention was called especially to this tank because I think it is one of the first instances of a Waring macerating tank which was ever shown and described to me. The chamber which I saw was the initial chamber similar to that in the cut on
4169 page 24 of the Flush-Tank Company's catalogue, and marked "intercepting chamber." I do not now recall whether or not there was a baffle wall in this chamber or not, but I remember that the inlet and the outlet were trapped by baffle walls. I could not say after this lapse of time as to the size of the tank, or as to whether it took the roof water from the

house or not. In the other instances cited I merely saw the covers of the two tanks and did not open the covers or look inside. Their arrangement was described to me at the time, however. In the Chase tank, as nearly as I remember, the effluent from the tank emptied upon the beach and soaked away into the sand. I do not recall specifically seeing 4171
this outlet, but I have a strong impression that it was there. Upon second thought it seems to me now that there was an old sewer in Belmont Avenue laid there by private parties prior to the construction of the sewer which I built there in or about 1886, into which this tank emptied.

XQ. 161. Have you ever seen any other tanks of 4172
the Waring type or tank similar to that illustrated upon page 24 of Flush-Tank Company catalogue besides the tanks you have enumerated in your last two preceding answers? A. I undoubtedly have, but I am unable at this time to locate them without a good deal of research and the effort of memory. In a general way I cover a great deal of territory 4173
in the course of my practice, and examine a good many cases where the problem of sewage purification comes up, and in these cases I have undoubtedly seen a considerable number of such installations, but as I have said in a prior answer, there are no records of these installations as they have usually been installed by architects rather than by sanitary 4174
engineers.

XQ. 162. In the course of your direct examination you have referred to a book entitled, "The Disposal of Household Wastes," by William Paul Gerhard, a civil engineer of New York City, and have specifically referred to the tank described on

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pages 75 to 79 in such book; and in the course of your description you say that the tank therein described is one "consisting of a closed tank practically light and air proof with submerged non-disturbing inflow and outflow, baffle walls for retaining the scum, and aeration by means of a weir over
4176 which the effluent from the tank flows. Descriptive cuts of these appliances will be found on page 180 and page 184." Will you please again examine Mr. Gerhard's book and state wherein you find any decription of "-submerged non-disturbing inflow," or where you find baffle walls for retaining the scum? A. In examining Mr. Gerhard's book again I find
4177 that I have confused the cut on page 184 of his book with a cut of the Flush-Tank Company's catalogue, page 24. The cut in Mr. Gerhard's book does not show a submerged inlet or a central baffle wall as in the case of Flush-Tank Company's catalogue and also Colonel Waring's book, page 291. The inlet, therefore cannot be said to be non-disturbing except in the sense that its proportion of flow may be
4178 small in proportion to the liquid contents in the tank.

Baffle wall for the retention of scum is, however, provided in Mr. Gerhard's proposed plant in the sense that the wall of the overflow pipe extends below the surface of the liquid and prevents the surface scum from overflowing.

4179 XQ. 163. Please state if the following are quotations from Mr. Gerhard's book entitled, "Disposal of Household Wastes," to which you have referred, viz.:

(p. 24). "The principle points of importance are that the sewage be applied to the soil while *fresh,* and before it begins to decompose.

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(p. 36). Generally speaking a detached country house, not in reach of sewers, can dispose of its sewage by one or the other of the following methods . . . . 3. The drain may deliver the sewage from the house into a tightly built cesspool provided with an overflow pipe carried into some ditch or water course. This is a makeshift arrangement, which cannot ordinarily be endorsed. 4181

(p. 44). Tight Cesspools—Passing over now to the consideration of tight cesspools, we find that they are built both with and without overflows. The former arrangement may be considered a direct outcome of the leaching cesspool. While such a tight cesspool, with overflow located far away from the house, and with its overflow carried, perhaps to some rapid stream, may be unobjectionable where but little water is used in the 4182
house, it constitutes in the case of larger houses a fearful nuisance, as the sewage, when removed, is already putrid. . . . .
The object of all good drainage being to get rid of filth from the premises at once or else to dispose of it on the premises while *fresh*, so as to be completely taken up by vegetation and purified by the soil, it is evident that a vast receptacle of accumulated filth cannot be considered a good device, from 4183
a sanitary point of view.

(p. 46). There are some cases where no good feasible way of dealing with sewage may be found, other than to run it into a tight cesspool. In that case the following precautions are to be observed. . . . . The cesspoool should at all times be well ventilated and must be emptied, cleaned and disinfected at frequent intervals."

(p. 58). "Subsidence—All attempts at sewage 4184
purification by simple subsidence have proved a failure. By collecting house sewage in subsidence tanks, which are usually nothing but cesspools, we effect merely a partial and very imperfect clarification, consisting in the settlement to the bottom of the heavier particles of sewage. The resulting effluent is of a very foul character, and the difficulty of disposing of the same remains.

4185 JOHN W. ALVORD.

(p. 74). Flush tanks for sewage disposal are best built of brick, laid in hydraulic cement mortar and made perfectly water tight. . . . . . .
Such a chamber is, in a certain sense a cesspool, or although differing from the ordinary objectionable device of this kind in having its liquid contents frequently changed, and in being built of small
4186 size. The emptying and cleaning of this chamber, must, of course, not be neglected.

(p. 83). Owners of country residences find an objection to the system in the necessity of emptying the intercepting chamber, claiming that this causes a nuisance.

(p. 120). A cardinal rule is that the sewage be delivered at its ultimate point of discharge before it can begin to putrify.

4187 (p. 131). Cesspools and vaults are retained in communities only through ignorance or indifference. It is a fundamental principle that all filth incident to human life should be removed and immediately, or at least before putrefactive decomposition begins.

(p. 167). But whatever system may be adopted in cities and towns, it is established beyond a question that all kinds of cesspools must be prohibited;
4188 that in particular the use of abandoned wells, as cesspools, must be regarded as a relic of barbarism, and that privy vaults with or without sewer connections, ought to be done away with. In other words, *all stagnation of sewage matters, with its unavoidable putrefaction, must be avoided.*"

A. Yes, these quotations are correct and it is a curious and instructive thought to notice that an
4189 author who can make the quotation last above underscored, should also say, as he does on page 79; "It is often objected that the intercepting chamber is in reality a cesspool. This is to a slight extent true, but nevertheless I always advise building it, using due precaution in its construction to make it perfectly tight." Also on page 75:

"Much of the solid matter and paper, etc., is reduced by maceration and decomposition and flows dissolved by water into the liquid sewage chamber."

There is certainly a singular contradiction here in the ideas of the author which is to me both significant and instructive.

4191

An earlier generation ignorant of the laws of communicable disease by bacteria imbibed a great dread of foul odors to which they largely attributed disease. This dread is inherent in the human race to-day, notwithstanding the newer light which bacteriology has brought to it. It is now not thought that foul air gives rise to disease. In fact it has been shown that workmen engaged during all their 4192
lives in the repair of sewers are found to be generally possessed of unusual health. This dread of foul odors derived from the ignorance of precise laws which govern the communication of disease to my mind, explains the crusade which was inaugurated by the earlier sanitarians against the putrefaction of sewage in the vicinity of domestic 4193
habitations. Insofar as their reasons were based on proper consideration they stand good to-day and are urged properly against the location of any sewage purification plants in the immediate vicinity of domestic dwellings, but insofar as their reasons were based on ignorance we must ignore the arguments which they used or assign them to sentiment- 4194
al consideration.

We find them, as I have before said, an earlier generation of sanitarians preaching the removal of sewage in its fresh state to the place in which it must be properly disposed for the reason that they conceived that the odors of putrefaction gave rise to

4195 disease. That this state of mind lasted well into the period when bacteriology became better understood and the causes of disease better defined can be readily seen. We find, therefore, in Mr. Gerhard's book, as we find in Colonel Waring's book, and in the writings of most everyone who came under his
4196 influence, two sets of ideas which are antagonistic to each other. The first set being a survival of the earlier and more ignorant ideas concerning the propagation of disease by foul odors, and the second set of ideas being the earlier discovery founded on the science of bacteriology.

It is to my mind, of great significance that these
4197 sanitarians and scientists who thus wrote were nevertheless honest enough to admit that maceration and dissolution of organic matter as a valuable preliminary in sewage purification were at the same time filled with the earlier idea that all putrefaction, especially in the vicinity of domestic dwellings must, if possible, be avoided.

4198 Mr. Gerhard was, of course, a follower of Colonel Waring, and his book is a very close copy of Colonel Waring's ideas.

XQ. 164. Do you think that the periodical flushing out by rain water, for example, of a tank of the Waring type, such for example as shown upon page 24 of Flush-Tank Company's catalogue would have
4199 the effect of removing or carrying away the solid matter, and thus avoid the necessity of cleaning out the tank at frequent intervals? A. There was a period in my earlier study of this subject when I was inclined to believe that this might be so. A careful study of a large septic tank at Lake Forest, in 1902, which periodically received a considerable

rush of comparatively fresh rainwater led me to modify this view as I observed increased efficiency from this tank for several weeks following each flushing.

I am of the opinion from this and other similar studies that the composition of organic solids by bacteria or by micro-organisms is accompanied by 4201
the accumulation of the wastes of bacterial life which are inimical to their activity and vitality. These wastes need to be removed by constant inflow and outflow, or by the introduction of a considerable body of water at stated times, and I have observed that the latter invariably results in increased bacterial activity in spite of a common the- 4202
oretical opinion to the contrary.

I should not, therefore, consider the flushing of the preliminary or intercepting chamber of a Waring type of house sewage purification plant as being detrimental but rather beneficial.

XQ. 165. In the course of your deposition, in what way, if at all, have you differentiated a sep- 4203
tic process of sewage disposal from a sedimentation, subsidence, or settling process? A. I have never succeeded in drawing any distinction between the two in my own mind which was satisfactory to me.

I am aware that the claims of the Cameron patent make this attempt, but so far as my practical observation has gone that which is conducive to a 4204
good sedimentation tank produces a good septic or liquefying action and that which does not promote good sedimentation conditions does not promote good decomposition conditions.

XQ. 166. In pronouncing certain tanks of the prior art as anticipations of the claims of the Cam-

4205 eron patent, have you disregarded the extent to which liquefaction of solids may have been carried in such prior tanks? A. In selecting types of sedimentation tanks which I consider to be anticipations of the septic tank, I have endeavored to confine myself to those which were apparently operat-
4206 ed so as to produce decomposition, that is to say, taking those sedimentation tanks which are cleaned infrequently, I have conceived them to necessarily have a considerable amount of decomposition and liquefaction. In some cases, notably at Ealing, this is shown by analysis.

In sedimentation tanks which are cleaned daily
4207 or even once in a few days it is apparent that the decomposition of solids must be inferred with by agitation to a considerable extent, and that the best results are not being obtained from the septic tank point of view. On the other hand, where tanks are cleaned infrequently, say once in eight weeks, as is decribed in the case of the Cheltenham tank
4208 by Henry Austin, I conceive that such a cleaning is desirable and necessary from the point of view of a successful decomposition tank, as in my opinion the ash or wastes of decomposition should be removed from the tank from time to time in order to keep the liquid contents of the tank at its greatest capacity.

4209 XQ. 167. Can you not state a frequency of cleaning that would prevent the successful operation, in your opinion, of a tank as a septic tank, with more exactness than you have done? A. I think it is not a question which can be answered exactly. The constant removal of the sludge daily from a sedimentation tank, in my opinion, interferes with de-

composition but does not stop it—it only retards it. Consequently the less frequent removal of the sludge retards the decomposition less and less until a point is reached where some removal of accumulated mineral deposits is not particularly injurious except for the time being, and is perhaps helpful in increasing the liquid contents of the tank. Just 4211
where this interval of time should be placed in which beneficial removal can be made will vary in each locality with the variation in the constitutents of the sewage itself.

XQ. 168. In your opinion, would a sedimentation tank that was cleaned, say as often as once a week or once in two weeks, or was neglected al- 4212
together, operate as a successful septic tank? A. The whole question as to whether a septic tank is successful or not successful as a septic tank is an indeterminate one as it is a matter of opinion merely. To my mind a successful septic tank is one which has produced the maximum of decomposition with a minimum of outlay. In the case you men- 4213
tion, that of a tank cleaned once in two weeks, I should say that if the tank were properly proportioned with relation to the incoming sewage its quantity and quality, that such frequent cleaning as you mention would be a waste of investment in that the full benefit of the tank would not be derived. In the case of a tank which is wholly neglected 4214
there would also be a waste of investment, as the full liquid contents of the tank would not be available. But in either of these two cases I could not see that decomposition or septic action was by any means stopped completely.

XQ. 169. I assume therefore, that in view of the

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opinions you have just expressed, that you have felt at liberty when considering tanks of the prior art to disregard the extent or degree to which these tanks effected the liquefaction of the solids and to pronounce such tanks as anticipating the process of the Cameron patent. Is that corect? A. No, sir,
4216 on the contrary. In selecting tanks which have seemed to me to be anticipations of the Cameron process, I have been particular to take only those in which it seemed to me clear that the ideas of the designer were to produce liquefaction and which were essentially operated so that a reasonable degree of decomposition or liquefaction without too
4217 frequent disturbance would necessarily result.

XQ. 170. In your answers to Q. 15 and Q. 16, and to XQ. 37 to 41 you have enumerated the various tanks which you regard as anticipating the process claims of the Cameron patent in suit. Please state by what names these various tanks are designated in the publications or patents wherein
4218 they are described? A. They are variously described as settling tanks, separating tanks, sedimentation tanks, subsidence tanks, straining tanks, screening chambers, filter tanks, grease traps, catch basins, cesspools, macerating tanks, and intercepting chambers.

XQ. 171. Do you consider that with respect to
4219 all the tanks and systems which you have declared to be anticipations of the septic process of the Cameron patent, the publications from which you have derived your knowledge as to such tanks and their operation has given such full information with regard thereto as to leave no doubt in your mind that such prior tanks were in all cases so properly pro-

portioned and were in all cases operated under such conditions and with such degree of attention as you have stated in your various writing to be essential to the successful operation of a septic tank? A. I consider the information at hand fairly complete enough to base an intelligent opinion. In some cases this opinion must be based upon the state- 4221
ment that no complaints have ever been made of the operation of the plant, as for instance is the case of the Worcester tank which I have cited, in other cases the opinion must be based on the ideas of the designer as disclosed by the plans and not in the language of those who have described the plant which I have pointed out is in certain instances un- 4222
sympathetic. Taken as a whole, however, I believe the instances I have cited are fairly well substantiated as being efficient plants for the decomposition of the solids in sewage.

XQ. 172. Do you not think that some of these tanks of the prior art might have operated successfully as sedimentation or settling tanks and yet the 4223
character or volume of the sewage may have been such that they did not operate successfully or necessarily as septic tanks? A. It seems to me from such a study as I have made of them that they must have operated successfully as septic tanks.

XQ. 173. Is it your belief that the revelation in the art of sewage disposal that has been generally 4224
attributed to Mr. Cameron's work is in fact due to the settling tanks, the sedimentation tanks, the flush tanks and the cesspools of the prior art which you have enumerated in the course of your deposition? A. I should be disinclined to admit that Mr. Cameron had worked a revolution in the art

of sewage purification. What has worked a revolution in the art of sewage purification has been our advance in knowledge of bacteriology, an advance which has been contributed to by a large number of scientists, sanitarians, engineers and others working contemporaneously during the past twenty
4226 or twenty-five years. Mr. Cameron's contribution to this advance, in my mind, consists in pointing out that the dissolution of solids, such as had been discovered by Alexander Mueller, patented by Louis Mouras, exploited by Professor Pagliani, and indicated in the suggestions of Henry Austin and which had been independently discovered in this
4227 country by Colonel Waring and elaborated by his followers, such as William Paul Gerhard, Benezette Williams, Professor Talbot, Mr. MacHarg and many others, was equally applicable on a large scale to the disposition of sewage of towns and cities as it had already proven to have been in the disposition of the wastes of large residences and public institutions.

4228 XQ. 174. Are the following excerpts from writings and discussions by you published on the dates in the publications stated, or in the conventions stated?

"MICHIGAN STATE BOARD OF HEALTH,
TRAVERSE CITY CONVENTION,
August, 1899.

4229 "While our own conclusions in the matter had been as a result of the labors of the Massachusetts State Board of Health that large areas of sand beds would effectually filter the sewage of cities, it has been found in these Western States that such areas do not always exist in sufficient quantities and it has been necessary to seek other methods, chemical and otherwise, and these newer processes latey developed in England promise the purification of sewage without such lands, and it is with these that I have been more especially interested during the last year. Early a year ago my attention was called to these processes and I made a special study of them."

ENGINEERING NEWS.
September 7, 1899. 4231

"In March, 1898, after careful studies into the more recent English methods of bacterial purification of sewage had been made for the City of Columbus, O., and their trial then recomended, beginning on a small scale, an opportunity was afforded us to install a plant of this character for a large golf and polo club house near Chicago.

* * * * * * * * * * * * * * *

The results of the season's experience having 4232
met our most sanguine expectations it was determined to increase the capacity of the plant.

* * * * * *

Chemical and bacteriological records cannot be given at this time. No full record of this kind was made of the first season's work. But the physical conditions were closely observed and recorded. The true test of the plant was in the
fact that during 1898 it abated a nuisance with but 4233
two brief exceptions throughout the season under the most exacting conditions, and when the plant itself was theoretically insufficient in capacity for the work it had to do."

STATE BOARD OF HEALTH REPORT

FROM PROCEEDINGS OF FOURTH GENERAL CONFERENCE OF HEALTH OFFICERS IN MICHIGAN, 1899. 4234

"It is for this reason that those of us who have been obliged to encounter this difficulty have taken such interest in recent English Rapid bacterial methods, and we note that over there these methods promise so well that over 200 projects for plants of this character are now before the public, all of which are depending very largely upon

4235

the experience which has been gained for several years past in works which have been in operation at Barking, Sutton and Exeter. The difference between rates of filtration of 40,000 to 100,000 gallons per acre per day as now successfully practiced in bacteria oxidation beds installed in English places above mentioned is a very great one in point
4236 of first course; and the septic tank pointing as it does to the successful removal by the action of anaerobic bacteria of the sludge problem in sewage disposal, is indeed a most remarkable step in advance. From a practical experience of two years with these methods in the actual operation of a small installation I feel confident in saying that they will undoubtedly eliminate chemical precipitation as one of the reasonable methods of sewage purification, owing to the fact that the same results
4237 are obtained at far less cost and much greater efficiency by these new methods."

ENGINEERING RECORD, Mch. 16, 1901, p. 247.

"There is a general rush just at the present time to introduce a septic tank into sewage purification works new and old. * * * * The writers have operated several septic tanks during the past three years, one of which has had close attention
4238 during the whole of that time.

The first season it was thought a simple affair to manage it; the second season it was concluded nothing was definitely known about its operation at all; the third season, in humbleness of spirit, it was realized that something was being learned about it, and in the course of another season it is hoped to learn even more.

This much, it is thought, has already been well
4239 learned, viz: That every sewage has its own most effective rest period, due to its strength, its temperature, its condition when received, and its variation in quantity. If any sewage is kept in a septic tank much longer than its proper rest period, it modifies the vitality and activity of the anaerobic bacteria by producing toxins, which, if allowed to accumulate, are detrimental to their vitality. If the rest period is unduly prolonged, the

bacteria are entirely destroyed and the tank at once fills up with organic matter, which runs over on to the contact bed, and the process of purification is stopped. A lovers' rest located over a tank at such a time as this would at least be unfrequented enough for anyone seeking quiet and seclusion.

On the other hand, an insufficient rest period 4241
produces little or no change in the effluent, except to subject it to rapid decomposition when again exposed to the air.

The strength of most sewage varies from time to time, and it is upon the strength as well as upon the total quantity that the rest period should depend. The temperature has much to do in determining the rest period."

JOURNAL OF THE WESTERN SOCIETY OF ENGINEERS. 4242

Vol. 7, No. 2. April, 1902.

SEWAGE PURIFICATION PLANTS.

(Page 115.)

"The newer and more recent biological processes, connected with automatic operating devices, it is hoped, will somewhat escape this difficulty."

(Page 118.) 4243

"Chemical precipitation, with all its expensive machinery, was invented for this purpose, but it does not accomplish what the septic tank accomplishes in that it leaves the sludge problem unsolved, and provides an effluent so loaded with disinfectant that is not easily oxidized."

(Page 115.)

"Sewage purification has had its origin and
greatest development in England, where crowded 4244
populations located on insufficient water sheds gave rise to an incredible nuisance which would seem intolerable in our own country. England has for forty years past wrestled with the sewage problem, and it is safe to say that over one-half of the sewage of the United Kingdom today passes through some form of attempted purification. It is but natural that England should have

kept in the lead in this problem, and its most interesting recent developments have found their greatest appreciation in that country."

(Page 119.)

"The septic tank has passed through a period of doubt and distrust and is now being carried along on the popular wave of enthusiasm. It has
4246 come to pass that almost anyone thinks he can design such tanks, although he may only have read of them."

(Page 126.)

"The enormous expense of operating chemical purification renders it quite certain that at no distant day the largest portion of the plants of this character will be replaced by the septic tank, where the same work is accomplished with practically no operating expense. It is because of this
4247 fact that we see the present enthusiasm for the septic process."

THE PRACTICAL OPERATION OF SEWAGE PURIFICATION PLANTS. APRIL, 1903.

(Page 3.)

"The revolution in sewage purification processes which has taken place in the last six or eight years has brought to the front a good deal of in-
4248 telligent discussion on the proper design of sewage purification plants based on the new biolitic methods. * * * *

NEW PROCESSES.

(Page 6.)

"The consideration which we have given to the general disadvantages which sewage purification plants labor under have operated in a marked
4249 manner in the older chemical and intermittent filtration and land methods. Newer processes, especially those utilizing automatic appliances for regulating and distributing the flow, would seem on the face of it to have greatly lessened the difficulty of supervision. This, however, is not wholly the case. Automatic appliances to a certain extent do away with an interior class of labor, but do not at all dispense with that thought-

ful care and study which is more than ever necessary in the biolitic processes."

A. The excerpts are correct and represent the opinions which I have expressed from time to time favorable to the dissolving of the solids in the sewage as a preliminary step by the septic tank so called. 4251

My attitude of mind upon first learning of Mr. Cameron's work by the publications in the Engineering News, of January, 1898, was that some new bacteriological process had been discovered by him. This arose from the broad claims which he made for the disappearance of solids, the exact description which he gave of the precise way in which the 4252
bacteria act, and certain minor details of the tank upon which he seemed to set great store.

In the course of the next ensuing six months I became convinced from my own studies of the history of the art and from experiments which I made, that certain details which he insisted as vitally necessary, were not necessary, and that liquefaction
or decomposition was not a new discovery. Subse- 4253
quent studies and experiments convinced me that his results were no better or more successful than the result of prior uses in the art. I, therefore, became convinced long before the issuance of the patent in this suit that I was entitled to design and operate tanks for the decomposition of the
solids in sewage as a continuation of the labors of 4254
those sanitarians who had given the matter earlier attention.

I have, therefore, been everywhere, and always a consistent advocate of the liquefaction or decomposition of the solids of sewage as a preliminary step in sewage purification and I have not hesitated to adopt the word "septic," originated by Mr. Cameron, because the wide publicity which was given his experiment, made it rapidly become a word which the public better understood than the word "liquefaction," "maceration," "subsidence," or "decomposition."

4256 In such articles as I have written on the subject since the granting of Mr. Cameron's patent, I have not attempted to withhold from him due credit for what I consider his contribution to the advancement of sewage purification as indicated in my prior answer; nor have I attempted to withhold from him credit for such claims in his patent as
4257 seem to me to be new or novel. I have only attempted to show what has seemed to me to be clearly proven not new or novel in the art—should not be properly credited to him or patented by him.

XQ. 176. Is the following a correct quotation from the discussion in the Seventeenth Annual Report of the Illinois Society of Engineers and Surveyors, January, 1902, (p. 222):

4258 "**Mr. J. W. Alvord:** There are a number of patents on the septic tank. An English firm claims to have patents on the whole principle. They have threatened the speaker's firm with suits for using such tanks. . . . The speaker's firm has found it necessary to patent their designs, to keep some of these people from taking the ideas and patenting them and selling them
4259 back. The speaker's firm is putting in septic tanks in defiance to the broad patents, and, although they have put in 16 tanks, they have had no trouble.

The septic tanks have been in use in this country so short a time that not much can be said about results. One of the tanks put in by the speaker's firm has been in use about three years, others for about a year."

And is the following a correct quotation from your pamphlet entitled, "The Practical Operation of Sewage Purification Tanks," published April, 1903, (p. 6):

PROPRIETARY CLAIMS.

"The endeavor to obtain a monopoly of the field of sewage purification by the owners of pro- 4261
prietary processes and patented claims has for some time past made it difficult for the sanitary engineer to hold his field of activity in this line of work without some embarrassment. It is not easy to convince city officials that sewage purification is a matter where thoughtful study and constant care in operation will tell in the long run better than the acceptance of a proposition
from a strongly financed company guaranteeing 4262
operation to certain standards for a given length of time. It is not that the art can be patented; it cannot be and there is not a patent now in the field that is particularly useful or valuable. . . . ."

And did you, in a letter addressed under date of August 15, 1904, to the Honorable Watts A. John-
son, Mayor of Princeton, Illinois, and published in 4263
the Bureau County Republican, September 1, 1904, use the following expression:

"I am in receipt of your letter of August 13th, with inclosed copy of notice to you by the Cameron Septic Tank Company as to the question of infringement of their patent, and beg to advise you that I consider their claims of no value what-
ever. . . . . . The use of tanks for the re- 4264
duction of sewage dates from early in this century, and has been in general use in the city of Paris for a great many years and there have been constructed in this country a great many tanks for this purpose prior to the granting of patent No. 634,423. .

I am paying no attention to the claims in the Cameron Company. . . . ."

A. The first quotation made is from a discussion
in the Illinois Society of Engineers, and the discus-
sions of this society are neither reported in full, nor
revised by their authors and are notoriously inacc-
rate. For instance, the statement that the writer's
firm had been threatened by suit is not true, and
4266 other statements made in the same discussion do
not seem to me to be accurate. I, therefore, object
to the introduction of this quotation, as not proper-
ly representing what I may have said on that occa-
sion.

The second quotation headed "Proprietary
Claims," is correct and was written by me as quot-
4267 ed.

The quotation from letter from myself to the
Honorable Watts A. Johnson is probably correct,
although I have no means at this time of ascertain-
ing the fact. I would like to state that prior to
writing this letter, the firm with which I was con-
nected, submitted the claims of the Cameron pat-
4268 ent to an attorney and received from him an opin-
ion which led us to believe that portions of the pat-
ent were anticipated in the prior art.

I also advised the committee of the citizens of
Lake Forest that such a patent had been issued,
whereupon said committee investigated the subject
fully and obtained expert opinion on the same, lead-
4269 ing them also to believe that the patent was invalid
for the reasons I have mentioned.

I, therefore, further, in the letter quoted to Mr.
Johnson, say:

"We have long wished that these people would
be honest enough to come into court and have
their preposterous claims adjudicated, but they
have so far perceptibly kept away from any legal

decision and confined themselves to intimidating our client in the hope that their unfamiliarity with the facts will lead to some form of settlement.

After four years of this policy it appears that they have finally succeeded in effecting a financial settlement with the city of Plainfield, New Jersey, for a sum obviously less than the cost of 4271
litigation which was started, and upon the strength of this they are now notifying every one who has adopted septic tanks with a view to establishing themselves in business. . . . . . . There are other patents for minor devices by this company which are doubtless novel and proper and which are not in use by you or any other of our clients. The patent, however, granting to the Cameron Septic Tank Company the right to reduce sewage in air and light tight tanks 4272
is, in our opinion, fatally defective in that it is neither new or novel, and I might also say that the form of tank in use at Princeton is neither light nor air tight as specified in the claims of the Cameron Company.

This whole subject was carefully investigated by Leonard Metcalf, a civil engineer of Boston, in a paper prepared by him for the American Society of Civil Engineers, and published in Vol- 4273
ume 46, December, 1901."

XQ. 177. Will you state where published descriptions or references are to be found to the various septic tanks or plants that have been built by you or your firm? A. In report of the Traverse City Convention of the Michigan State Board of Health, for August, 1899, will be found a descrip- 4274
tion of the plant which was installed at the Glen View Golf and Polo Club, in Chicago, in 1898. Also a further description of the same plant is found in Engineering News, September 7, 1899.

A description of septic tank, built at Holland, Michigan, is found in Engineering Record, of

4275 March 16, 1901. Also another account of the same plant is found in the Public Health Engineer, an English periodical, published April 13, 1901.

An account of septic tank built at Bedford, Indiana, is found in the Engineering Record, November 15, 1902.

4276 In a paper read before the Western Society of Engineers, published April, 1902, entitled "Sewage Purification Plant," are cuts and illustrations of plants built by myself at Lake Forest, Illinois; at Holland, Michigan; Danville, Kentucky; Wauwatosa, Wisconsin, and proposed plants at Scycamore, Illinois and Columbus, Ohio.

4277 In a paper read before the American Society of Municipal Improvements at the Rochester Convention, April 23rd, 1903, entitled "The Practical Operation of Sewage purification Plant," is found some description of the plants at Lake Forest, Illinois; Wauwatosa, Wisconsin; Holland, Michigan; Danville, Kentucky; DeKalb, Illinois; Highland Park, Illinois, and Glen View, Illinois.

4278 In the Engineering News for July 2nd, 1903, appears a description of septic tank plants for country residences, which I have designed and installed.

These are all of the published descriptions which I now recall.

XQ. 178. Did you state in your paper delivered
4279 at Rochester, in April 1903, the following with respect to your Lake Forest Plant:

"The tank has not been cleaned during the year, and no perceptible deposit has occured."

And did you state with respect to the DeKalb, Illinois plant,

"A septic tank of 60,000 gallons capacity has been in operating since the middle of the summer.

It is yet too soon to speak of its effectiveness. It is not as yet followed by any secondary stage. It has not yet required cleaning.'' And did you state with respect to other plants mentioned in said paper as follows:

"PRINCETON, ILLINOIS.

A 60,000 gallon septic tank has been in operation about one year. 4281 It is built on the five compartment system and housed over. It does not receive special attention, but good results are reported. If so they are probably accidental. It has never been cleaned, but some deposit on the bottom is reported. The rest period is not known. The plant was designed with intermittent filtration as a secondary stage, but the city is now hoping that the first stage will be sufficient to avoid nuisance. It re- 4282 mains to be seen if this hope will be realized.

DANVILLE, KENTUCKY.

Three septic tanks have been in operation here over one year. The largest is 40,000 gallons capacity, and is followed by intermittent sub-soil filtration. It is recorded to be working well, but receives no special attention. It is perhaps too early to draw conclusions concerning it. It has not required cleaning as yet. 4283

HIGHLAND PARK, ILLINOIS.

A small septic tank has been in operation on the west district for two years. It has received no attention whatever, and has caused no complaint as yet, it has never been cleaned. It is said not to be unduly filled with deposit. The effluent is reported as good, but the sewage it receives is not strong. It is noticed, as a matter of experience, 4284 that weak or thin sewage is not generally exacting in its treatment.

CONCLUSION.

The above data of some of the larger plants recently put into operation shows how little the majority of such plants are cared for after installation. If they avoid being obnoxious, it is often through their good fortune, and if they do become nuisances, it is often no argument that they may not be properly designed.

That this state of affairs is discouraging must be admitted, but with the over confidence that has come in the sewer biolytic process, it would seem to be inevitable.

4286 The sanitary engineer, working in the line of sewage purification must for some years to come in the future as he has in the past, educate his public up to a just appreciation of the state of his art. It is a tedious and thankless process in many respects, but the revolution in the art in the past few years, and the great possibilities of sewage purification for the future entails this responsibility upon him and he cannot avoid it."

4287 A. The quotations are correct.

XQ. 179. Will you please state how many cities having plants of your installation have been sued by the complainants in this cause; also state what you have done towards defending or guaranteeing the defense of such cities; also state what you have done towards affecting the combination of others
4288 towards the defense of the present litigation; also state by whom you are paid for your testimony in this cause; also state, if you know, the names of all the parties who are contributing to the defense of this cause? A. So far as I can remember, the only cities having plants installed under my designs which have been sued by the complainant in
4289 this cause are the City of Lake Forest, Illinois, and the City of Wauwatosa, Wisconsin.

I have done nothing whatever toward guarantying the defense of any such city as might be sued.

I have done nothing toward affecting the combination of others towards the defense of the present litigation, except to suggest the same.

I am paid for my testimony in this cause by the City of Saratoga Springs, New York; Madison, Wisconsin; Lake Forest, Illinois; Monmouth, Illinois, and the Allis-Chalmers Company of Milwaukee, and these, so far as I know are the names of all the parties who are contributing toward the defense of this cause. 4291

I have never guaranteed to defend or save harmless, any client for whom I have designed or constructed such plants.

Re-direct examination by Mr. Banning:

R-d-Q. 180. What proportion of your business or income is involved in the work of designing or installing sewage disposal plants? A. Probably not more than ten per cent. 4292

R-d-Q. 181. Please state how many of the sewage disposal plants installed by you since the issuance of the Cameron patent sued on, have tight tanks in the sense of excluding air and light, and how many have tanks not tight in this sense? A. So far as I now recall, none of the plants installed by me 4293 have air or light tight tanks. The usual method which I have adopted is to provide a light building over the tank with ventilators, windows and doors. In some of the smaller installations the tanks are covered with a new flooring of sufficient strength to prevent any person from falling into the tank. The only design I recall making for a tight tank in 4294 the sense of the Cameron patent strictly construed, was the proposed tank for Columbus, Ohio.

R-d-Q. 182. Please state how the tanks of the plants at Lake Forest, Illinois, and Wauwatosa, Wisconsin, referred to in XQ. 179 are constructed in this respect? A. In both of these cases the tank

is covered with a building with masonry walls, wooden roof provided, I think, with ventilators. Each of these buildings has two doors. The Lake Forest building has six windows and as near as I can remember, the Wauwatosa building has four windows. These windows are provided with solid
4296 wooden shutters so as to prevent malicious injury to the sash.

The Lake Forest tank has one of its initial compartments covered with a wooden floor and the building does not extend over this compartment which is relatively small, compared with the tank. The building, however, extends over what is called
4297 the dosing chamber, which is not a part of the tank proper.

The initial compartment which is covered by a floor and which receives the inlet sewer is called the grit chamber, while the septic tank proper is entirely covered by the building. The walls of the building rest upon the walls of the tank as a foun-
4298 dation, with the exceptions noted of the grit chamber and the dosing chamber, the former being outside the building, and the latter inside the building. The building proper extends about four feet above the tank to the eaves, and the gable is about eight feet above the eaves.

The Wauwatosa building is similar to the Lake
4299 Forest building in height. Its wall also rest on the walls of the tank as a foundation and the dimensions of the buildings are the same as those of the tank which it precisely covers.

R-d-Q. 183. Please state how these Lake Forest and Wauwatosa tanks compare with tanks of the prior art referred to in your testimony with ref-

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erence to excluding light and air? A. These tanks resemble very much in a general way the tanks described by Henry Austin at Cheltenham in England, which are also covered by a building. (See Defendant's Exhibit, Cheltenham Sewage Works, longitudinal section). They also closely resemble the building placed by Professor Talbot over the 4301
second Champaign tank. Considerable light and air enters such buildings under the eaves which in the Lake Forest and Wauwatosa plants were purposely left loosely open for ventilation.

R-d-Q. 184. Referring to cross question 59—which I take for the purpose of illustration—is the description of the Lawrenceville plant contained in 4302
Rafter & Baker's book, as introduced in this cause, sufficient to enable sanitary engineers or others skilled in the art to construct the apparatus and apply the process described in the Cameron patent sued on in this cause, and particularly specified and claimed in the claims against which you have cited such description or plant as a reference; and 4303
please answer the same question with reference to each of the prior patents and publications which you have referred to as anticipations of the Cameron patent? A. The diagrams and descriptive matter relating to the sewage purification plant at the Lawrenceville School for boys, page 511 and following of Rafter & Baker, is in my opinion sufficient- 4304
ly clear to enable anyone skilled in the art to construct a plant substantially like that specified in the claims which I have cited in the Cameron patent, as being anticipated in this plant; and the same is true of the Worcester plant, the plant at the Massachusetts Reformatory at Concord, plants at

4305 St. Joseph Orphan Asylum and Altenheim, near Chicago, the plant at Medfield, Massachusetts, and all of the other instances cited by me, with the possible exception of the plant at Ealing, in England. A description of the plant at Ealing, Santo Crimp, page 159, and following, is not clear as to
4306 some of the details of the inlet and outlet, but in my opinion provides for non-disturbing inflow and outflow because we have there an arrangement of compartment tanks of very great length in which case the disturbance of inflow and outflow is relatively unimportant.

R-d-Q. 185. In applying and using the sewage
4307 disposal tanks or plants of the prior art referred to in your testimony as anticipations of the Cameron patent, is the "septic" process so-called—by which I mean the process of said patent—necessarily and naturally involved and carried into effect? In other words, can any of such tanks or plants be used in the ordinary course for which they were constructed without applying and car-
4308 rying out such process? A. In all of the citations which I have made it is inevitable that with any ordinary or normal use of these tanks the septic process as described in the Cameron patent must necessarily ensue. It is impossible in my opinion that it should not occur.

4309 Re-Cross Examination by Mr. Fisher.

R-XQ. 186. If the process described and claimed in the Cameron patent in suit is, as you say, the inevitable result of the operation of the various plants which you have referred to as anticipating such patent, why is it that you have stated that you accord Mr. Cameron credit for

the advance that he has contributed to the art? A. Because the advance in the art of bacteriology made it evident that these processes were the natural and proper ones and were not necessarily confined to a small scale. The plants at Ealing, Wimbleton and other places were fairly large plants, but they were installed at a time when 4311
the knowledge of bacteriology was not complete enough to enable their designers to fully understand why the reductions were going on. Mr. Cameron made his experiments at a time when the knowledge of bacteriology was pretty complete and when people were rather credulous of the wonderful things that bacteriology might ac- 4312
complish. His experiments immediately called attention to the fact that this reduction which Dr. Mueller had studied, which Mouras had patented and which Henry Austin had described, was an inevitable and natural result, and could be applied on a much larger scale than has been thought possible by Colonel Waring in this coun- 4313
try or some of the workers abroad. That Dr. Mueller perceived that this process might be conducted on a large scale is evidenced from the fact that he speaks of it as being possible to adapt it to the use of towns. That Henry Austin fully perceived that it was a desirable process is evident, but he was not able to explain in his 4314
day what was happening so clearly as could Mueller, Mouras, Pagliani, Waring, Phillbrick and others. Mr. Cameron's experiments came at a time when attention had been diverted from the natural processes of decomposition and liquefaction to the somewhat unnatural processes of pre-

4315 cipitation and in this diversion of attention the work of the minority had been lost sight of to some extent. Mr. Cameron repeating the experiments of Dr. Mueller, Paglani, Mouras, Waring and others, and clothing his work with a name new to the history of the art—that of "septic"—
4316 attracted popular attention on the part of the public and turned the attention of scientists to the ideas of the minority who had heretofore developed the line and perfected the knowledge which Mr. Cameron availed himself of.

R-XQ. 187. In all the plants installed by you has not the surface of the sewage during the nor-
4317 mal operation of the tank been covered with scum? A. No, sir. The Lake Forest plant was not covered with scum for some years, but liquefaction was very rapid and complete during all of that time.

R-XQ. 188. To what did you attribute the absence of scum in the Lake Forest plant and was the absence of scum noticeable in any other plant
4318 installed by you during its normal operation? A. I had various theories to account for it, no one of which I felt was quite certain to be the true one. I have also recently observed a tank which was constructed under my advice in which there was very little scum on most of the compart-
4319 ments and yet active liquefaction was evidently proceeding. In this case I thought the cause was due to some agitation caused by the rapid inflow of the sewage in the tank. This agitation, however, did not seem to injuriously affect the working of the tank. I do not recall any other plant at this time in which this absence of scum was so noticeable.

R-XQ. 189. Will you please state, first, whether there is a scum at present in the Lake Forest tank; second, how often you observed the absence of scum from the Lake Forest tank as compared with the length of time the surface of the tank has been covered with scum; third, what
were the character and volume of sewage of the 4321
Lake Forest tank at the time you observed the absence of scum—I mean the character and volume as respects the normal; fourth, in what other tanks installed by you you have observed the absence of scum, and what was the condition of the sewage of such tank at such time, and how long
had the tanks been in operation? A. The last 4322
time I observed the Lake Forest tank was some time in the fall of 1904, at which time there was considerable accumulation of solids in the first compartment. The final compartments did not seem to be covered with scum, although liquefaction was proceeding with rapidity in those compartments as was evidenced by bubbles of gas 4323
constantly coming to the surface.

The effluent was good and the sewage entering the tank was normal in character and quantity.

I recommended that the initial compartment be cleaned out, as the surface scum extended about two-thirds the depth of the compartment and seriously reduced its liquid contents. 4324

This was the first time this tank was cleaned since it was put into operation. I have not seen it since it was cleaned.

Answering the second portion of your question I would say that I observed the absence of scum on the Lake Forest tank practically one-half of

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the time since it has been in operation. This applies to the whole tank. During this time the character and volume of the sewage was normal in quantity and quality- except that after rainstorm a considerable flush would take place through the tank. There would be times when
4326 the scum would form to a thickness of six or eight inches and remain for some months. Then a flush from a rainstorm would apparently break this up and for some time no further scum would form.

Answering the fourth part of your question I recall that the tanks at Holland, Michigan,
4327 showed very little scum for nearly a year after they were put in operation. Liquefaction was active and the effluent was good. There was no rainwater admitted to the sewer, but a very considerable quantity of ground water perforated into the sewers and the sewage was very dilute. I have not seen these tanks for some time and
4328 do not know what their present condition is. This is the only other tank which I recall where the absence of scum was marked.

JOHN W. ALVORD.

Adjourned till Wednesday, September 20, 1905, at 11 o'clock A. M.

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September 8, 1905, 10 o'clock A. M.; met pursuant to adjournment; present as before.

The further taking of Mr. Alvord's testimony is suspended to enable the examination of Mr. Charles B. Burdick, Rev. Vincent Huber, and Mr. Henry W. Hill, whose depositions are to be in- 4331
serted in the record immediately following Mr. Alvord's completed testimony.

Charles B. Burdick, a witness produced, sworn and examined on the part of defendants, deposes and testifies as follows in answer to questions by Mr. Banning.

Q. 1. Please state your name, age, residence and 4332
occupation? A. Charles B. Burdick, age 31 years, residence, Chicago, occupation sanitary and hydraulic engineer. I am associated with Mr. John W. Alvord in the practice of sanitary and hydraulic engineering.

Q. 2. Are you a practical draftsman? A. I
am. 4333

Q. 3. Please look at this drawing I now hand you, entitled "Defendant's Exhibit Sewage Tank at St. Bede's College, Peru, Ill." and state who made it and what you know about it? A. This drawing was made by me upon Sept. 6, 1905, and represents a sewage tank examined by me on that
date at St. Bede's College, Peru, Illinois. 4334

Q. 4. Please state how you came to make such drawing, what examination you made of the sewage tank which it represents, and whether or not it correctly represents said sewage tank as examined by you Sept. 6, 1905? A. I was instructed by Mr. John W. Alvord and Mr. Ephraim Banning, to

go to St. Bede's College, Peru, Illinois, and examine the sewage tank in operation at that place, and to take such measurements as are necessary to correctly represent same upon a drawing, which I did. I made a careful examination of the tank and the drawing correctly represents the tank as I saw it
4336 upon that day.

Q. 5. Please describe that tank as you saw it day before yesterday, stating how it was constructed, whether it was in use, etc? A. The tank is constructed of brick masonry. It is circular in horizontal plan, nine feet and six inches in diameter, and ten feet in depth. The inlet consists of a
4337 15-inch sewer pipe, the bottom of which is located four feet below the top of the tank. The outlet upon the opposite side of the tank from the inlet consists of a wooden box twelve inches by twelve inches in cross section. The entrance to the outlet box is covered or masked by a brick partition wall under which the sewage must pass in entering the
4338 outlet box, thus preserving a scum upon the top of the sewage. The outlet box is so located as to maintain a depth of sewage in the tank of five feet and six inches, and the tank is covered over by a two-inch plank top which was in bad condition at the time of my examination. The tank is constructed in excavation entirely, the surface of the ground
4339 being level with the top of the tank.

For added clearness I would say that the tank may be described as a cylinder set on end, nine feet and six inches in diameter, and ten feet in height, with a masonry bottom and a wooden plank cover. At the time of my visit sewage was entering and leaving the tank. A scum was formed over the top of the sewage, and more or less sediment had collected at the bottom.

Q. 6. Please describe the effluent from that tank and the conditions below the tank as examined by you day before yesterday? A. The effluent from the tank was slightly clouded, but contained no 4341
solid particles of sewage. The ditch through which the sewage flows away gave a slight evidence of decomposition having taken place in the sewage discharged. There was a slight odor perceptible. This odor may perhaps have arisen largely from the stirring up with a pole of the contents of the tank in making measurements of depth and ex- 4342
aminations below the sewage line.

Counsel for defendants offers in evidence the drawing identified by the witness and the same is marked Defendants Exhibit Sewage Tank at St. Bede's College, Peru, Ill.

Counsel for complainant admits that 4343
the drawing referred to is the same drawing referred to by the witness Alvord in his deposition in his answer to question 12; but counsel objects to the introduction of the exhibit and to the testimony in respect thereto as immaterial, there being no proof as to the date of installation of 4344
the tank illustrated by the exhibit, and for the further reason that the introduction of the exhibit is unwarranted by the answer in this cause; and subject to such objections counsel cross examines the witness as follows:

4345 C. B. Burdick.

Cross-examination by Mr. Fisher.

XQ. 7. Did you ever see the sewage tank at St. Bede's College prior to Sept. 6, 1905? A. No, sir.

XQ. 8. Did you remove the contents of the tank
4346 before you examined it? A. I did not.

XQ. 9. I assume, therefore, that you were unable to inspect any part of the tank below the top line of the sewage. Is that correct? A. No, sir, that is not correct. I, by means of a pole, prodded around in the sewage sufficiently to satisfy me that the conditions represented below the sewage line
4347 are as shown upon the drawing. I could very easily demonstrate the depth of the tank, the fact that the bottom was constructed of masonry, the depth of the baffle wall and by shoving a pole into the outlet as it appeared on the bank from ten to twelve feet below the tank. I demonstrated that the brick partition masked the outlet. The elevation of the outlet box is determined by the level
4348 of the sewage in the tank, or rather the elevation of the sewage in the tank is determined by the outlet box.

XQ. 10. In what way did you determine the thickness of the bottom of the tank? A. I did not determine the thickness of the bottom, as same
4349 could not be done without great difficulty, and I did not regard it as material to my examination of the tank.

XQ. 11. So that so far as the thickness of the bottom of the box is concerned the drawing made by you does not give any definite information. Is that correct? A. That is correct.

XQ. 12. And I assume you are unable to say of what material the bottom of the tank is formed? A. I am unable to say further than that I am satisfied it was masonry of some kind, which was demonstrated by the sound produced by striking the bottom with the end of the pole..

XQ. 13. In what way, if at all, did you determine wether the wall of the tank below the sewage line and the bottom of the tank were in sound condition or not? A. I examined the same by feeling with a long pole and the wall was not broken or injured in sufficient amount to be detected by that means of investigation. 4351

XQ. 14. In what way did you determine the depth below the sewage line of the masonry partition that is shown upon the drawing as in front of the outlet box? A. By standing on the opposite side of the tank from the outlet I prodded the wall near the outlet until I demonstrated that the wall ended a short distance below the sewage line. 4352
I then drove a nail in the side of my pole near the lower end and standing over the outlet of the tank I hooked the nail under the bottom of the partition and marked the pole at the lower edge of the cover, which distance represents the distance from the top of the tank to the bottom of the partition. The difference between this distance and the distance 4353
from the top of the tank to the sewage line represents the distance which the partition is submerged. 4354

XQ. 15. Did you observe the character of the soil in which this St. Bede's tank was located? A. Immediately at the tank vegetation is quite thick. Twelve or fifteen feet to the southward the box

4355 outlet ends in a ditch. The bottom and sides of the ditch were covered with soil with some evidence of gravel. Further than that I did not investigate the character of the soil in the field.

XQ. 16. Please describe the condition of the cov-
er of the tank at St. Bede's College, when you in-
4356 spected the tank on Sept. 6, 1905? A. The boards
composing the cover were apparently considerably
decayed. Two or three of the planks in the center
of the tank had apparently been broken from some
cause and had fallen into the tank, leaving an open-
ing in the top of the tank and extending across
same, the width of the opening being from two to
4357 three feet.

XQ. 17. Were the planks forming the cover of the tank tongued and grooved? A. Not to my knowledge.

XQ. 18. Was there any ventilator on the top of the tank? A. None was in evidence.

XQ. 19. In what condition did you find the out-
4358 let box that led from the tank? A. The outlet box
where I examined it at the lower end was consider-
ably decayed, but not sufficiently so that it had lost
its form entirely. The planks were somewhat
sprung from the top.

XQ. 20. In what way did you take your measure-
ments of the outlet box leading from the tank? A.
4359 I measured it at the point where it emerges from
the ground at the ditch. I shoved the pole into the
outlet box until it intercepted the brick wall, and
from this fact I approximated the length of the
box, which I stated above.

XQ. 21. How long was the pole that you employed in your examination of this tank? A. I did not measure the pole, but I should judge it was sixteen or eighteen feet long.

XQ. 22. In what way did you determine the thickness of the partition wall in front of the outlet of the tank? A. This thickness was not measured closely. It may have varied somewhat from the thickness as indicated on the drawing. I made an 4361
effort to approximate it by shoving the pole into the outlet box until it struck the wall, and then laying it on the ground, with its end even with the inside of the partition wall. It was impossible, however, to obtain a close measurement in this way, and the thickness of the wall may vary slightly from the thickness shown upon the drawing. 4362

XQ. 23. Do you know whether the brickwork forming the wall of the tank was laid in cement or ordinary mortar? A. I have no means of knowing definitely. I should judge, however, from the good condition of the masonry that the brick was laid in cement. There was no lining of cement visible.

XQ. 24. Did you make any test or examination 4363
to determine the amount or character of the sewage entering the tank or the effluent passing therefrom? A. No further than to look at it closely. The sewage coming in, carried some considerable floating organic matters and the sewage flowing from the tank apparently contained very little, if any, floating organic matter. The volume of the sewage 4364
flowing to and from the tank at the time of my examination was a small stream in the bottom of the 15-inch inlet pipe, about four or five inches wide. I did not measure the depth, but I should judge the flow was in the neighborhood of five or six thousand gallons per twenty-four hours.

XQ. 25. About what period of time did your observation of the operation of the tank cover? A. About forty-five minutes, from five fifteen to six P. M.

XQ. 26. Did you observe the extent and character of the scum on the surface of the sewage in
4366 the tank? A. I observed that there was a scum over the surface of the tank covering practically the entire aera. It was broken at a few points near the center immediately beneath the inlet. The scum was gray in color, but was not as hard or thick as I have seen it in septic tanks. The scum was not of such character as to be easily measured. Judg-
4367 ing from its appearance as stirred up by the pole which I used in investigating the tank, I should say it was from three to four inches thick.

XQ. 26. Was this scum in patches or was it continuous over the surface of the tank, or were there open spaces in the scum when you first observed the tank? A. As I stated before, practically the en-
4368 tire aera of the tank was covered by scum. There was a patch under the inlet, perhaps 18 inches or two feet square not covered by scum. There were perhaps two or three patches near the center of the tank, about the size of a man's hand not covered by the scum.

XQ. 27. Did you observe the surface of the
4369 ground at or some distance below the outlet, and if so what was the extent and nature of the deposit that you found? A. The surface of the ground was covered with vegetation around the tank. In the ditch immediately below the outlet I saw some deposit of black substance which had apparently come from the tank. The bottom of the ditch was

simply dirty from the effluent which had passed through it.

XQ. 28. Was there a stream of water flowing
through the ditch? A. I examined the ditch only
about thirty or forty feet from the tank. I should
judge that there was no water flowing in the ditch
other than that coming from the sewage tank. 4371

XQ. 29. In what way, if at all, did you measure
the depth of the deposit or sludge in the bottom of
the tank? A. I used a long pole which was thrust
into the sewage and for a few inches before reach-
ing the bottom of the tank in thrusting the pole
downward, the pole pushed hard or not so easy as
when being pushed through the sewage alone, show- 4372
ing that some substance more dense than the sew-
age in the tank had collected on the bottom. As
the pole was drawn up, there was evidence of it
having passed through some black muddy sub-
stance for several inches, at its lower end.

XQ. 30. Did this black muddy substance that ad-
hered to the pole when you withdrew it from the 4373
tank correspond in apearance to the deposit that
you say you found in the bottom of the ditch below
the outlet? A. I did not critically examine either
the deposit in the bottom of the tank nor the de-
posit in the ditch. They were similar in that they
appeared to be about the same color. So far as
could be judged by the rather imperfect evidence of 4374
the marks upon the pole when it was withdrawn
from the bottom of the sewage tank.

XQ. 31. Did the deposit which you say you saw in the ditch below the outlet of the tank extend up along the sides of the ditch above the level of the water flowing therein? A. The ditch was bare for a distance of perhaps twelve inches upon either side of the flowing stream. The color of this bare ground, as near as I can state without having made a critical examination of it, was the same as the bottom of the ditch.

XQ. 32. Did you observe any odor in the ditch
4376 as far down as you went? A. I observed some odor all about the place. It is impossible for me to state whether this odor came from the ditch or from the tank. The odor was strongest at the tank, but the condition I observed was probably somewhat artificial from the fact that the contents of the tank had ben considerably stirred up through my inves-
4377 tigation. There was some odor about the place before the contents of the tank was disturbed.

CHARLES B. BURDICK.

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Reverend Vincent Huber, a witness produced,
sworn and examined on the part of defendants,
deposes and testifies as follows, in answer to ques-
tions by Mr. Banning:

Q. 1. Please state your name, age, residence and
occupation? A. Reverend Vincent Huber, 50 years 4381
of age, St. Bede College, Peru, Illinois. I am the
Rector of the College and one of the professors.

Q. 2. How long have you been Rector of St.
Bede's College, Peru, Illinois? A. I was appoint-
ed Rector in the beginning of September, 1897,
and continued to hold that office till April, 1902;
continued as professor at the college till June, 4382
1903; then I went to Colorado, where I remained
for one year, after which I was again appointed
Rector and Professor at St. Bede College, which po-
sition I continue to hold. I have been there con-
tinuously with the exception of that one year which
I spent in Colorado.

Q. 3. As Rector of St. Bede Colloge, what are 4383
your particular duties, especially with reference
to oversight of the property? A. I have the com-
plete management of the college and buildings and
farm attached.

Q. 4. Has that been the case during all the time
you have been there? A. It has with the exception
of the one year when I was not the Rector. 4384

Q. 5. Do you know anything about any sewage
tank connected with the buildings of St. Bede Col-
lege, at Peru, Illinois? If so, how long have you
known about that tank personally? A. I do. The
sewage tank is located about 150 yards south of the
college. All sewage of the buildings is led into this

4385 tank. I have known of this tank since September, 1897.

Q. 6. Please describe that tank, and state whether it has been in use all the time you have been there, how it operates, etc. A. The tank is circular, constructed of brick. The diameter of the tank is
4386 about nine feet. Its depth about ten. The inlet from the north side is by tile, about fifteen inches in diameter. On the inner side of the south side, there is a projection into the tank extending to within about four feet from the bottom. This constitutes a trap through which the contents of the tank find their outlet. This tank has been in use
4387 ever since I came to the college, in fact since the construction of the college in 1891. I know this to be a fact from information given me by professors who had been at the college from its first opening. A. The tank was constructed for the purpose of gathering into one place through channels from various parts of the building all the sewage, rain-
4388 water, laundry water, and everything of the buildings. It serves that purpose very well, has required no attention since I have been at the college, and as I know from others, received none before my time.

Counsel for complainant objects to such parts of the foregoing answer as relates
4389 to matters not within the personal knowledge of the witness as being hearsay and not the best evidence.

Q. 7. So far as your knowledge goes, what is the operation or effect of collecting all the sewage together in that tank, particularly with regard to the solids in the sewage? A. Evidently a great quantity of solids enter the tank through the inlet. As these have never been removed, the solution of the solids must take place, and being liquefied find their exit through the outlet.

Q. 8. Has that tank ever been cleaned out since you came there or during the time you have been there? A. The tank has not been cleaned out dur- 4391
ing the time that I have been there.

Q. 9. Is your position such that you would have known it, if it had been cleaned out? A. It is, as no such work would be done without my direction.

Q. 10. As I understand you, that tank was there at the time you first came to St. Bede College, in
September, 1897, is this correct? A. It is. 4392

Q. 11. Has any change ever been made in it, or any work of any kind done upon it or in reference to it since you first came there? or rather during the time you have been there? A. None whatever, except that a new cover of planks, which had rotted, may have been put there.

Q. 12. Please describe more fully than you have 4393
done, how that tank was covered or is covered? A. It was completely covered with plank, laid side by side. They were not dovetailed. It was covered by 2-inch plank laid side by side, but not fastened together. The planks were loose.

Q. 13. But was the tank so covered over as to
make it practically a tight and dark chamber? A 4394
At the time when I last saw the tank two of the planks had rotted through, and had fallen into the tank. These planks had not been replaced, and therefore left openings in the cover. The planks that were still in place were so laid that the wood formed a practically tight and dark chamber.

Hence, before these two planks rotted away, the space under the cover was practically tight and dark.

Q. 14. How is the sewage discharged from that tank? A. The sewage must pass under a wall which projects down and over the outlet, and
4396 then is discharged through a wooden box leading from the tank into a ravine.

Q. 15. Have you ever had occasion to notice the ditch or ravine through or over which the sewage flows after leaving the wooden outlet connected with the tank? If so what did you see? A. I have frequently observed the ravine. From
4397 the end of the box to the spot at which the sewage flows into the ravine is a distance of from ten to fifteen feet. For that distance the sewage has made its own path. The ravine extends four to six hundred feet above this inlet. It has no flowing water except in very wet weather, when the surface water from the fields is carried off by
4398 it. There are two tile drains above the inlet, none below. The ravine at the place where this sewage flows into it is not more than 12 feet deep. Farther away its depth increases until it reaches forty or fifty feet. The flow of the sewage is rapid, owing to the steepness of the ravine.
4399 The bottom of the ravine is very rocky. The sewage meanders through these rocks, leaving a deposit very dark in color and somewhat slimy. The offensive odor is not so very noticeable except just in the ravine. This water is taken up by the ground, so that at a distance of 500 yards from the tank it disappears entirely, except in very wet weather.

Q. 16. Are any solids carried out from that tank and deposited at any point below the wooden outlet so far as you have ever observed? A. So far as I have observed, no solids are carried from the tank.

Q. 17. How many people does that tank serve? 4401
A. The number has varied during my sojourn at the college from 100 to 175 or 180 approximately. Today it is about 150, next week it will likely be 180, as the scholars are not yet all in.

Q. 18. Are you able to state how long sewage is held in that tank, or have you any way of estimating it? A. The only way in which I could 4402
answer this question would be by considering the capacity of the tank and the amount of sewage that flows into it. The tank is large enough to hold the sewage of approximately two days.

Q. 19. Have you ever observed whether any scum is formed on the top of the sewage in that tank? If so, with what result? A. I have ob- 4403
served that to a depth of about five to six inches the surface of the contents in the tank are more or less solid. The solids swim upon the top, as oil would float on the water Beneath the inlet there is a space which is entirely free of this scum, this space being about a foot and a half in diam-
eter. 4404

Q. 20. Please look at this drawing, which I now hand you, marked "Defendants' Exhibit Sewage Tank at St. Bede College, Peru, Ill.," and state whether it represents the tank which you have been testifying about? A. It does.

Cross-Examination by Mr. Fisher.

XQ. 21. Did you ever give any directions in regard to repairs or changes on the tank at St. Bede College? A. I did not.

XQ. 22. So far as you know, was there ever a new cover placed upon that tank? A. No new
4406 cover was placed over the tank since I came to
St. Bedes.

XQ. 23. When did you last examine the tank at St. Bede's College? A. I last examined the tank on Wednesday, the 6th instant.

XQ. 24. Was that the first time that you noticed that the cover of tne tank had rotted
4407 away in part? A. It was.

XQ. 25. I assume, therefore, that a long time must have elapsed between the time when you last examined the tank and the time of your next preceding examination. Is that correct? A. I never had made a thorough inspection of the tank before, but I frequently passed it and saw
4408 that the cover was partly rotten and needed repair.

XQ. 26. When did you first have occasion to remove the cover and examine the interior of the tank? A. I did not examine the interior of the tank at any time previous to the date mentioned.

XQ. 27. Is it not a fact that you gave no
4409 thought or attention to the tank prior to Wednesday last? A. I knew the tank was there, the purpose for which it was there, and that it had to serve that purpose, and did serve that purpose. Hence I frequently thought of the tank, realized its importance, but never made it an object of worry. I really did not inspect the tank because

 4410

I took it for granted that it was serving its purpose, and no defect was reported to me.

Q. 28. How many times prior to Wednesday last have you examined the effluent issuing from the discharge spout of the tank? A. I have noticed it hundreds of times in passing by, but
have never made any other physical or chemical 4411
examination.

Q. 29. What was the occasion of your examining the tank on Wednesday last? A. Mr. C. B. Burdick presented a letter of introduction from Mr. Hill, requesting me to show him the location of the tank, and to offer him every facility of
making an examination of the same. I accom- 4412
panied Mr. Burdick to the tank and gave him what assistance I could in making his investigation.

XQ. 30. Did you notice the effluent from the tank prior to beginning the examination of the tank on Wednesday last? A. I saw it at a distance of
about thirty feet from where I stood. 4413

XQ. 31. You have stated that you have noticed the effluent of the tank hundreds of times. Was your observation from the distance of thirty feet or nearer, or farther from the tank? A. I frequently observed it from within a few feet from the tank, and also at all distances from the tank down
to 300 yards from the tank. 4414

XQ. 32. When you last noticed the effluent, what appeared to be its color and condition? A. The color was a very deep blue or dark, and there was a greater flow than usual due, presumably to the fact that much water from the laundry passed through the sewer on that occasion. I could frequently see the effect upon the effluent of the tank due to the water coming from the laundry in which bluing had been used.

XQ. 33. If I understand you correctly, you attribute the increase in the flow and the color of the effluent to the fact that the laundry was in use on
4416 Wednesday last when you made the examination? A. I said that it was probably due to that.

XQ. 34. How far from the ravine is the tank located? A. The tank is located about twenty to twenty-five feet from the ravine.

XQ. 35. Did you ever observe the deposit in the ditch leading from the outlet of the tank, and in the
4417 ravine? A. I did.

XQ. 36. Please describe the character and appearance of the deposit, as you observed it? A. The appearance of the matter flowing through the ravine was different at different times. When the laundry was in operation it was bluish and soapy. In wet weather when the ravine carried off great
4418 quantities of surface water from the fields or from the field drain tiles, the water was practically clear. In dry weather, and particularly during the Summer months when less water and sewage flowed through the tank and ravine, the flow was very dark, even black.

XQ. 37. Did you ever observe the effluent issuing
4419 from the outlet of the tank after a rainstorm, and if so what was its appearance then? A. I did not.

XQ. 38. The water from the roofs of the buildings of the college and from the laundry all passed through the tank. Did it not? A. It does.

XQ. 39. Did you ever observe the effluent at the outlet of the tank, or between the outlet and the ravine, during rainy weather or after a storm? A: I do not now remember that I ever did.

XQ. 40. Did you ever observe the outlet of the tank at any time when there was an unusually large outflow therefrom, and if so, state its appearance at such time? A. I have a few times observ- 4421
ed such an unusual outflow due to transient causes in the buildings, such as a large discharge of water from the laundry. At such times the effluent was of a much lighter color. At such times it was soapy and foamed considerably as it went down through the ravine. I have frequently seen such bodies of foam collected at various places down the ravine.

4422

XQ. 41. When was the odor about the tank found to be most objectionable? A. I never noticed any smell or odor from the tank, except when the wind blew in my direction, and then I never made any particular observation which would enable me to say whether it was more perceptible at one time than at another. There was 4423
a path about 70 feet from the tank, and from this distance I repeatedly noticed the offensive odor.

XQ. 42. And I understood you to say also, that in the ravine below the tank, you noticed an odor. Is that correct? A. It is, but there the odor was less perceptible than near the tank, and at a dis-
tance of about 300 yards from the tank where a 4424
private road crosses the ravine, I do not remember noticing any disagreeable odor.

XQ. 43. Can you approximate the amount of water delivered to the tank during a heavy rainstorm and its effect upon the contents of the tank? A. I cannot.

XQ. 44. How did you measure the depth of the floating matter on the surface of the tank on Wednesday last? A. I made no measurements myself, but from my observations made during the time that Mr. Burdick was making investigation, I arrived at the judgment as to the thickness of this
4426 scum. He moved a pole through this scum and also shoved down the planks that were lying in this scum, and by doing this we obtained a sectional view of this scum.

XQ. 45. What is the character of the water system that has been used at St. Bede's College since you have been there? A. The water is pumped in-
4427 to a tank outside of the building. The capacity of the tank is about 11,000 gallons, and from this tank the water is distributed to all parts and stories of the buildings.

XQ. 46. Can you state how much water you understand to be used per day at the college? A. The amount of water used per day varies probably
4428 from 2,000 to 8,000 gallons per day. The lowest estimate is for the time the school is not in session, and the highest estimate represents the amount used during the school year, particularly on washday.

REV. VINCENT HUBER.

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 4430

Henry W. Hill, a witness recalled on the part of defendants, deposes and testifies as follows, in answer to questions by Mr. Banning:

Q. 1. Since your other examination in this cause,
have you made a personal examination of the sew-
age tank at St. Bede's College, Peru, Illinois, refer- 4431
red to in such examination? If so please state the
result, and particularly whether you found the con-
struction different from that described in your
former testimony, making any corrections or ex-
planations you consider necessary? A. Last Sat-
urday, September the 2nd, I went to St. Bede's
College for the purpose of inspecting the work go-
ing on there. Naturally when I found the time I 4432
went down to the sewage tank, and to my surprise,
found a tank different from the one described in
my previous testimony. The fact of this matter is
that the brick sewage tank was first contemplated
in our plan, but that subsequently the question
came up whether it would not be advisable to in-
crease the capacity of the tank, and I suggested 4433
the construction of a tank as I described, and I was
of the opinion that that tank had been built. When
I gave my testimony, I was requested by Mr. Ban-
ning to see whether any record of the tank was in
our office, and at lunch time I requested our man
who has charge of the drawings deposited in our
vault to see whether he could find the drawing of 4434
the wooden sewage tank built at St. Bede. He
could not find them, but since I was at Peru last
Saturday, I looked up the files of the original draw-
ing in the vault and I found the original sewerage
plan on which the section and plan of the present
tank are drawn. I found at Peru a brick tank cir-

cular in diameter, built in the character of a large catch basin with a trap at the outlet. The tank was covered with wood planks which were partly destroyed, or decayed. On my return to Chicago, I immediately wrote a letter to Messrs. Banning & Banning, stating that I had erred in my memory of
4436 the sewage tank built at Peru, and asked the privilege of correcting my testimony if such they deemed necessary.

Q. 2. Please go on and describe the sewage tank at St. Bede's College as you saw it last Saturday, and as illustrated in the original drawing which you have here produced, making such explanation
4437 of said drawing and quotation from written matter thereon as you consider necessary? A. Our original plan shows a tank, ten feet in diameter, while the one built is nine feet six inches in diameter. It is built of 12 inch thick brick wall, laid in German Portland Cement. It has a brick trap wall, four inches thick, which in our drawing shows
4438 to be built up to the bottom of the top cover, while in reality it was built only a little above the overflow pipe. It shows in the front part of the tank a wooden ventilator, about 12 inches wide. I saw that ventilator laying there tumbled over. This ventilator was put there to let the odors arising escape. It was not to let air in, but let smells out.
4439 The trap wall being stopped just above the overflow pipe, does not alter its purpose from the one shown in our drawing. Our specification reads that it should be built on a plank foundation, three inches thick, and I do not know whether that was changed, but if it is built of wood, constantly under water, there is no reason why it should not be in

the same condition as originally. The top shows a wooden tank cover as built. This cover I noticed last Saturday, was partly rotten and a few planks fallen down into the tank. On the original drawing is a written description of the tank and sewerage system of the college building, the part relating to the tank being as follows: "Build 450 4441
feet south of boiler house, in the direction of the main 15 inch sewer, a round sewage tank, ten feet in diameter, with 12 inch thick brick wall laid in German Portland Cement deep, built on plank foundation with trap. The outflow to be a wooden box, 15 inches square, about 10 feet long, all as shown on digram." 4442

Q. 3. Since your former examination, have you found any original book entries relating to the construction of that tank? If so please state what they are, quoting them into the record as a part of your answer A. On page 91 of our regular account book, I find that the contractor who built the sewerage system of St. Bede College, including 4443
the tank, Mr. Charles Birkenshaw, received on December 5th, 1890, a certificate in full, the amount of $1,532.75. This is the original entry in our regular account book, kept at that time.

Counsel for complainant waives the entry in evidence of the original book of ac- 4444
count referred to by the witness, and agrees that the statement made by the witness of the item appearing in said book be received with the same force and effect as if said book itself had been offered in evidence.

4445

Q. 4. In your former testimony you stated that the sewage tank at St. Bede's College, Peru, Illinois, was built in 1891. What do you find the facts to be at the time it was built? A. It was built in 1890, instead of 1891. Our term of building extended from the Fall of 1889 till the Fall of 1891,
4446 but in referring to the book I find the sewage tank was built in 1890.

Q. 5. When was the college opened and the sewage tank put into active use? A. The college was opened at the Fall term of 1891 and the entire sewerage system was put into use at that time. That included the sewage tank.

4447 Q. 6. As I understand your answer to question 2, the top of that sewage tank was built as shown in the original drawing which you have produced here to-day? A. Yes, sir. There were 2 by 10 inch plank laid closely together, and I believe that the planks that are there to-day are the original planks, because I find the original ventilator
4448 there.

Q. 7. Please look at this drawing which I now hand you, marked "Defendants' Exhibit, Sewage Tank at St. Bede College, Peru, Ill.," and state whether it correctly represents that tank as you saw it last Saturday? A. Yes, sir, it does in every particular, except that I do not know that the bot-
4449 tom is of masonry.

Q. 8. In your former testimony you stated that the roof area of the St. Bede College Buildings was about 15,000 square feet. If you wish to make any correction in this respect, please do so. A. That statement was made just from memory, without having the plan at hand. From the original drawing now before me I have computed the area of all the roofs of the different buildings, and find the same to be 18,720 square feet.

Q. 9. This original drawing which you have produced here to-day is entitled, "Plan of Sewerage for St. Bede's College Buildings at Peru, Ills., Bauer & Hill, Architects." Please state when and by 4451
whom this drawing was made? A. That was made in the Fall of 1889, at our office under my personal supervision.

Counsel for defendants offers said drawing in evidence, and it is agreed that a tracing thereof may be used in place of the original, such tracing to be marked, 4452
Defendants' Exhibit, Original Drawing, St. Bede Sewerage System.

Cross-examination by Mr. Fisher:

XQ. 10. Did you examine the tank at St. Bede's College after the tank was finished? A. Yes, sir.

XQ. 11. When you examined it, did it have a 4453
wooden bottom? A. That I do not remember.

XQ. 12. Do you think it would be possible to tell by prodding the bottom with a pole whether such bottom was made of masonry or plank? A. It would be very difficult to tell the difference. I don't believe you could tell the difference.

XQ. 13. How do you know that the brickwork 4454
of the tank was laid in cement, and not in common mortar? A. Our specification calls for German Portland Cement and the work was executed by Charles Birkenshaw who was a sewer builder of the highest reputation, being personally on his work all the time and never did any dishonest

4455 work. The brickwork which I saw last Saturday was in perfectly sound and good condition which is proof to me that it was laid in Portland Cement.

XQ. 14. Was there any ventilator used upon the top of the tank? A. Yes, sir. It was made from one inch plank, about ten or twelve inches square

4456 and about three feet high, with two sides open. It had a little shed roof on it of plank and the two opposite sides were left open about ten inches square. I saw that ventilator last Saturday tumbled over laying on the plank cover.

XQ. 15. State, if you know, the size of the tank used for supplying water to the college buildings

4457 at St. Bede College? A. I should judge it is a tank 15 feet in diameter and about 18 feet high. I have not measured the tank. It may be somewhat smaller.

HENRY W. HILL.

4458

4459

CIRCUIT COURT OF THE UNITED STATES, 4460
NORTHERN DISTRICT OF NEW YORK.

CAMERON SEPTIC TANK COMPANY of Chicago,
vs.
VILLAGE OF SARATOGA SPRINGS. 4461

The answer of the defendant, the Village of Saratoga Springs, to the bill of complaint of the Cameron Septic Tank Company of Chicago, the complainant herein, this defendant now and at all times saving and reserving unto itself all the benefits and advantages of exception which can or may
be had or taken to errors or uncertainties, or other 4462
imperfections, contained in said bill of complaint, for answer thereto, or unto, so much thereof as said defendant is advised is material for its answer, says:

1st—That it is a municipal corporation created by and under the laws of the State of New York,
and having only the powers conferred upon it by 4463
its charter; that the exclusive management and control of the system of sewers in the Village of Saratoga Springs, and of the disposal of the sewage of said Village, and of all apparatus, appliances and devices for the disposal of such sewage, are and were at the several times mentioned in the
bill of complaint, by law vested in the Sewer, 4464
Water and Street Commission of Saratoga Springs, N. Y., which is and was at all such times constituted by law a body corporate, and is not under the direction nor control of this defendant: that it is provided by law that all actions or proceedings on account of any act done or omitted by the said

4465 Commission shall be brought against the said Commission in its name of the Sewer, Water and Street Commission of Saratoga Springs, N. Y., and that all the acts mentioned in the bill of complaint, if such acts were in fact performed as therein alleged, were done and performed by the said Sewer, Water and Street Commission of Saratoga Springs, N. Y., and not by this defendant.

4466 2nd—That it denies that Donald Cameron, Frederick James Commin and Arthur John Martin, subjects of the Queen of Great Britain, and residents of Exeter in the County of Devon, England, were the original or first inventors of any new and useful improvement in processes of and apparatus for treating sewage, as alleged in the said bill of
4467 complaint, and says that it is not true that said alleged invention was not known or used in this country, and not patented or described in any printed publication in this or foreign countries, before their invention thereof, or that the same had not at the time of their application for a patent therefor, been in public use or on sale for more
4468 than two years.

3rd—That except by said bill of complaint, it is not informed whether letters patent for said alleged invention, in due form of law, were issued to Donald Cameron, Frederick James Commin and Arthur John Martin, subjects of the Queen of Great Britian and residents of Exeter in the County of
4469 Devon, England, or wether said alleged letters patent were signed and countersigned according to law, were issued under the seal of the Patent Office, and delivered unto the said Donald Cameron, Frederick James Commin and Arthur John Martin, and it leaves the complainant to make such proof thereof as it may, and it denies that said letters

patent granted to said Donald Cameron, Frederick 4470
James Commin and Arthur John Martin, their
heirs and assigns, for the full term of seventeen
years, or for any other term, the sole and exclusive
right, or any other right, to make use and vend the
said alleged invention throughout the United States
and the territories thereof, or any right whatsoever. 4471

4th.—And this defendant further answering,
says, as to the several averments of the bill of complaint
respecting the several alleged assignments of
said letters patent, that it has no knowledge except
as derived from said bill of complaint, and therefore
leaves the complainant to make such proof
thereof as it may be advised is material and necessary, 4472
and it may be able to produce.

5th—And this defendant further answering as
aforesaid, says that it has knowledge, except that
derived from said bill of complaint, as to whether
the complainant in this cause now is or ever has
been the sole and exclusive owner, or other owner,
of said alleged letters patent, or of the invention
and improvements therein described and claimed, 4473
or of any rights secured by said letters patent, and
it leaves the complainant to make such proof thereof
as it may be advised is material or necessary, or it
may be able to produce, this defendant denying
that any of the alleged rights in the bill of complaint
specified with respect to said alleged letters
patent ever had any existence, in the complainant 4474
or any person or corporation through whom said
complainant claims.

6th—This defendant further answering, says
that it has no knowledge that the complainant has
expended large sums of money and devoted
much time and effort to the developing of said in-

4475 vention, and to the devising and providing means
of carrying on the business of building, installing
or licensing others to build or install the struc-
tural combination of said letters patent, and mak-
ing the same profitable to itself and useful to the
public.

7th—And this defendant further answering,
4476 denies that said alleged invention has been of great
advantage and utility to the public and is capable of
being made a wide-reaching public benefit, or of any
public benefit, and denies that it is highly conducive,
or conducive in any degree, to the public health.

8th—This defendant further answering, denies
that at the time alleged in said bill of complaint,
4477 or any other time, this defendant made, constructed
or used, or is now using any apparatus for, or pro-
cess of, treating sewage contained or emoraced in
the alleged invention described or patented in or
by said letters patent No. 634,423, and denies
that it has unlawfully and wrongfully made or con-
structed or used, and is now using sewage aparatus
containing, and in its structure and operation em-
4478 bracing, the invention described and patented in and
by said letters patent No. 634,423, and denies that
it has infringed upon the exclusive right, or any
right of the complainant thereunder, and denies
that it has in any way infringed upon any rights
of the complainant or intended to do so, and it
denies that it has occasioned large damages to
4479 the complainant and made and realized manifold
advantages therefrom, or that it has derived and
received and is still deriving and receiving great
gains and profits, or any gains and profits what-
soever and avers that the complainant has
not incurred any damage by any unlawful or
wrongful act of it, the defendant. It denies that

the alleged use of said alleged invention, by the 4480
defendant, or its alleged appropriation thereof or
any unlawful or wrongful acts of the defendant in
disregard of the alleged rights of the complainant,
have had, now have, or ever have had the effect to
greatly encourage and induce or in any wise induce and encourage others to venture to infringe
the alleged letters patent in disregard of the al- 4481
leged rights of the complainant.

9th—And this defendant further answering, says that the letters patent sued upon, are invalid for want of patentable invention.

10th—And this defendant further answering, says that the alleged letters patent of the complainant have never been adjudged valid in any
action brought thereon, and that their validity 4482
has not been acquiesced in by the public.

11th—This defendant further answering, says that the apparatus described in said letters patent was not an invention when produced by said Donald Cameron, Frederick James Commin and Arthur John Martin, and was not novel at that time.

12th—The defendant further answering, says 4483
that said Donald Cameron, Frederick James Commin and Arthur John Martin were not the original inventors and first discoverers of the invention purporting to be covered by said letters patent, or of any material or substantial parts thereof, and that the same material and substantial parts thereof had
been in public use in this country prior to said 4484
alleged invention, and for more than two years prior to the application, and the same has been described and illustrated in printed publications prior to the date of said supposed invention of said Donald Cameron, Frederick James Commin and Arthur John Martin.

4485 13th—This defendant further answering, says that the alleged invention of Donald Cameron, Frederick James Commin and Arthur John Martin, had been previously invented and used by many other persons whose names are unknown to defendant, and which, when known, it prays leave to set forth in this answer.

4486 14th—This defendant further answering, says that the letters patent mentioned in the bill of complaint, were not granted for any invention or discovery of any new and useful art, machine, manufacture, or composition of matter, nor for any new and useful improvement thereof not known or used by others in this country and not patented or de-
4487 scribed in any printed publication in this, or any foreign, country before the invention or discovery thereof by the persons to whom such letters were issued, and not in public use or on sale for more than two years prior to their application.

15th—And this defendant further answering, avers that the complainant has full and adequate
4488 relief at law, and has not set forth in its said bill of complaint such facts, matters and things as are essential to the jurisdiction of a court of equity in the premises.

Wherefore, said defendant having fully answered the complainant's said bill of complaint in so far as it is advised the same is material and necessary
4489 to be answered, denies that said complainant is entitled to the relief demanded in said bill of complaint, or in any part thereof, or any relief whatsoever, and prays the same advantage of its aforesaid answer as if it had pleaded and demurred to said bill of complaint, and prays to be dismissed hence, with its reasonable charges in this behalf.

In witness whereof the President of the 4490
Village of Saratoga Springs has hereunto
(Seal) affixed the corporate seal of said Village
and has caused the same to be attested by
the Village Clerk.

ADELBERT P. KNAPP,
President of Village of Saratoga Springs.

4491

Attest:
C. H. KNAPP,
Village Clerk.

J. P. BRENNAN,
EDGAR T. BRACKETT,
Solicitors for and of Counsel for Defendant.

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4494

4495 UNITED STATES CIRCUIT COURT—NORTHERN DISTRICT OF NEW YORK.

CAMERON SEPTIC TANK COMPANY,
Complainant,
vs.
THE VILLAGE OF SARATOGA SPRINGS,
4496 AND THE SEWER, WATER & STREET COMMISSION OF SARATOGA SPRINGS,
Defendants.

In Equity, No. 7,020.

AMENDMENT TO ANSWER.

4497 Now come the defendants and amend their answer as follows:

By cancelling paragraphs 12 and 13 of the answer heretofore filed in this case, and substituting therefor the following:

12. The said invention having been disclosed and patented or described in the following Let-
4498 ters Patent and publications:

UNITED STATES LETTERS PATENT.

	No. 138,250,	dated	April	29, 1873,	to	Fritz Hille
	" 108,664,	"	Oct.	25, 1870,	"	Geo. W. Wigner
	" 184,099,	"	Nov.	7, 1876,	"	G. R. Moore
	" 258,744,	"	May	30, 1882,	"	A. S. Glover
	" 223,826,				"	G. E. Waring
	" 280,545,	"	July	3, 1883,	"	Silas Wilcox
	" 315,912,	"	April	14, 1885,	"	Robert Corscaden
4499	" 366,333,	"	July	12, 1887,	"	Marble & Knapp
	" 367,576,	"	Aug.	2, 1887,	"	G. A. Allen
	" 368,071,	"	Aug.	9, 1887,	"	Loring Coes
	" 403,946,	"	May	28, 1889,	"	Meyer & Weck
	" 424,838,	"	April	1, 1890,	"	Frank L. Union
	" 476,654,	"	July	12, 1892,	"	Elmer F. St. John
	" 484,823,	"	Oct.	25, 1892,	"	Ernest E. Scruby
	" 505,166,	"	Sept.	19, 1893,	"	Oluf L. Meyer
	" 530,622,	"	Dec.	11, 1894,	"	W. D. Scott-Moncrieff
	" 556,594,	"	March	17, 1896,	"	Frank L. Union
	" 268,120,	"	Nov.	28, 1882,	"	L. Mouras
	" 580,793,	"	April	13, 1897,	"	G. D. Mitchell

BRITISH LETTERS PATENT. 4500

No.	232,	dated Jan.	30, 1860,	to	Thomas Walker
"	2,329,	" Sept.	22, 1864,	"	Walker & Walker
"	3,203,	" Oct.	20, 1868,	"	Gavin Chapman
"	3,562,	" Nov.	23, 1868,	"	Smith & Bazalgett
"	364,	" Feb.	8, 1870,	"	G. W. Wigner
"	742,	" March	11, 1872,	"	Denton & Field
"	1,706,	" June	14, 1870,	"	Bevan George Sloper
"	2,760,	" Oct.	17, 1871,	"	James Brough Pow
"	5,391,	" Dec.	9, 1881,	"	Wm. R. Lake (a communication from Louis Mouras)
"	7,134,	" May	16, 1887,	"	Wilhelm Gurtler 4501
"	3,312,	" March	1, 1890,	"	Adeney & Parry
"	22,747,	" Dec.	30, 1891,	"	Joseph Tertius Wood
"	8,671,	" May	2, 1894,	"	Frank B. Candy
"	21,142,	" Nov.	8, 1895,	"	Cameron & Commin
"	23,042,	" Oct.	17, 1896,	"	Cameron, Cammin & Martin

GERMAN LETTERS PATENT.

No. 9,792, dated Dec. 11, 1879, to Alexander Muller

FRENCH LETTERS PATENT.

No. 144,904, dated Sept. 22, 1881, to J. F. Mouras 4502

ALSO IN THE FOLLOWING PUBLICATIONS.

A publication entitled "Fourth Annual Report of the Massachusetts State Board of Health for the Year 1872."

Also a publication entitled "Special Report of the Massachusetts State Board of Health," published in 1876. 4503

A publication entitled "Journal of the Society of Arts" (British), published for the Society by George Bell & Sons, 4, 5 and 6 York Street, Covent Garden, London, 1882; particularly the article beginning on page 532 and entitled "Some Practical Aspects of the Recent Investigations on Nitrification," by Robert Warington. 4504

Also a publication entitled "Report of the 54th Meeting of the British Association for the Advancement of Science," held at Montreal in August and September, 1884," published in London, 1885, by John Murray, Albemarle Street, and es-

4505 pecially the article therein beginning on page 682, and entitled "On Nitrification, by R. Warington."

Also a publication entitled "Minutes of Proceedings of the Institution of Civil Engineers With Other Selected and Abstracted Papers, Vol. LXXXVIII.," edited by James Forrest, published
4506 by the Institution at London, 25 Great George Street, Westminster, S. W., 1887, and especially an article beginning at page 155, entitled "Sewage Sludge and Its Disposal." by William Joseph Dibdin.

Also a reprint of a report to the London County Council, entitled "Report by the Chem-
4507 ists on the Experiments on the Filtration of Sewage Effluent During the Years 1892-3-4-5," and printed as a part of the "Interim Report of the Commissioners appointed in 1898 to inquire and report what methods of treating and disposing of sewage (including any liquid from factory or manufactory process) may properly be adopted,"
4508 Vol. 2, Evidence, the same being published in London in 1892, and especially a paper by Mr. Dibdin therein.

Also a publication, being a report by Mr. Henry Austin, C. E., Chief Superintending Inspector of the Board of Health, London, published in Lon-
4509 don in 1857, entitled "Means of Deodorizing and Utilizing the Sewage of Towns," with especial reference to the description of the Clifton Union Works, the Cheltenham Sewage Works, the Sewage Works at Ely and the "Proposed Sewage Works."

Also a publication entitled "Journal of the So-

ciety of Arts," Vol. XLVII., London, published 4510
for the Society by George Bell & Sons, 1898; especially page 263.

Also a publication entitled "Minutes of Proceedings of the Institution of Civil Engineers," Vol. 48; especially the article beginning on page 350, entitled "Mouras' Automatic Scavenger."

Also the same publication, Vol. LXXII, pub- 4511
lished 1883, page 359, an article entitled "The Theory and Active Working of the Automatic Scavenger."

Also the same publication, Vol. LXXVIII, published 1884, and especially page 502.

Also a publication entitled "The Engineering
News," published in New York, April 15, 1882, 4512
and especially an article on page 117 entitled "An Automatic Vault Cleaner."

Also a paper read at the "Seventh International Congress of Hygiene and Demography," held in London in 1891; entitled "Application of a Reservoir Interceptor Made on the Type of
Mouras Fose and of a Peat Filter for Sewage in 4513
the System of Separate Sewerage," by L. Pagliani, Professor of Hygiene and Director of Public Health in Rome, Italy, the paper referred to being in print and stamped with a rubber stamp "American Society of Civil Engineers, New York,
August 25, 1891." 4514

Also a printed pamphlet entitled "Extracts from the Press on the Scott-Moncrieff System for the Purification of Sewage," the same containing extracts from various British Press publications as follows: "Pall Mall Gazette," September 24, 1892; "Suffolk Times," September 30,

4515 1892; "Engineer," October 14, 1892; "Hampshire Advertiser," July 26, 1893; "Pall Mall Gazette," June 21, 1893; "Builder," August 12, 1893; "Industries and Iron," October 6, 1893. This pamphlet having been furnished witness Snow by Mr. Scott-Moncrieff, and extracts from a paper purporting to be read by Mr. Scott-Mon-
4516 crieff on the 5th of October, 1893, at Powchester, printed in "Industries and Iron," October 13, 1893.

Also a book entitled "Sewage Disposal Works," by W. Santo-Crimp, published in London, 1890; the special article referred to being a description of the tanks are Croyden; also a de-
4517 scription in the same book of the Merton Sewage Disposal Works, on page 151, in connection with Plate 12; also a description on page 164 of said publication of the tanks at Chiswick, England.

Also in the publication heretofore referred to, "Minutes of the Proceedings of the Institution of
4518 Civil Engineers," for 1877, Volume XLIX, pages 180-182, an article by Professor H. Tanner.

Also the same publication, Volume LXXVI, 1884, an article by Santo-Crimp entitled "The Wanole Valley Main Drainage."

Also in the same publication, Vol. LXXIX, page
4519 351, an article by Alfred Barton Brady entitled "The Burnham Sewerage Works."

Also in the work by Santo-Crimp above referred to, published in London, 1890, an article on page 194, a description of the works at Friern Barnet; and on page 216, a description of the works at Wimbledon.

Also a report of the Royal Commission on Sewage Disposal, July 28, 1898, Vol. II, entitled "Evidence of the Interim Report of said Commission." 4520

Also the publication "Minutes of the Proceedings of the Society of Civil Engineers for 1889," pages 392-93, a description by W. H. Lindley, in Vol. XLVI, of the tanks at Frankfort, Germany.

A publication in book form by George E. Waring, Jr., entitled "Sanitary Drainage of Houses and Towns," published in 1876. 4521

Also a publication in book form entitled "Sewage and Land Drainage," by George E. Waring, Jr., 3rd Edition, New York, D. Van Nostrand Company, London, 1891, especially pages 287, 288, 291, 292. 4522

Also a publication or catalogue entitled "Flush Tank Company, Chicago, Manufacturers of Automatic Siphons for Intermittent Flush Tanks," 169 La Salle Street, Chicago, Ill., 1892; and especially pages 24-26.

Also a publication in book form by George E. Waring, Jr., entitled "On the Modern Methods of Sewage Disposal," published in 1894, pages 216-218. 4523

Also a publication entitled "Sanitary Engineers," a periodical regularly published in the City of New York; especially an article entitled "The Disposal of Sewage by Special Surface Irrigation in Suburban Residences," by Edward S. Phillbrick; the same being published in the said Sanitary Engineer in the issue of May 10th and May 18th, 1883. 4524

Also a publication in book form entitled "Sewage Disposal in the United States," by George W. Rafter and M. N. Baker, published in 1894, 4525 New York, D. Van Nostrand & Company; London, Sampson, Low, Marston & Company, Limited, especially an article beginning on page 458 entitled "Broad Irrigation at the Worcester State Hospital for the Insane." Also page 507, an article relating to "Intermittent Filtration of the Massachusetts School for the Feeble Minded."

4526 Also a publication entitled "19th Annual Report of the Massachusetts State Board of Health for the year 1887," especially an article on pages 100-101, on the sewage disposal system at Medfield, Mass.

Also a publication entitled "Transactions of the American Society of Civil Engineers," published in
4527 1887, an article relating to the sewage disposal system at the Lawrenceville School at Lawrenceville, New Jersey.

Also in the Report above referred to entitled "Interim Report of the Commissioners," printed in 1898, Vol. 11, Evidence; especially questions and answers Nos. 1862, 1891, 1892, 1893, 1894, 1927,
4528 1935, 1937, 1938, 1939, 1940, 1959, 1962, 1964, 1968, 1971, 1972, 1973, 1974, 2014, 2015, 2017, 2018, 2019, 2048, 2049, 2059, 2060, 2063, 2064, 2065, 2069, 2070, 2071, 2079, 2080, 2081 and 2158.

Also a publication entitled "Cosmos les Mondes," published weekly in Paris, especially articles of December, 1881, page 622, January 21, 1882, page 97,
4529 and January, 1883, page 110.

XIII. On information and belief the defendant further says that the alleged invention, or material and substantial parts thereof described and claimed as new in said letters patent No. 634,423, and attempted to be patented thereby, had been in public use in this country for more than two years before the application of said Cameron, Commin & Martin for said letters patents by the persons and at the places following: 4530

At the St. Joseph Orphan Asylum, Chicago, Illinois, and known to William S. MacHarg, William E. Dee and Browne & Kavanaugh, of said Chicago, and others.

At Champaign and Urbana, Illinois, and known
to Professor Arthur N. Talbot, of Champaign, Illi- 4531
nois, and C. B. Burdick, of Chicago, Illinois; John C. Quade; and John C. F. Sell, Urbana, Illinois.

At St. Bede College, Peru, Illinois, and known to Henry W. Hill, of Chicago, Illinois; Charles B. Burdick, of Chicago, Illinois; and Vincent Huber, of Peru, Illinois.

At Rochester, Minnesota, and known to William 4532
S. MacHarg, Chicago, Illinois, and others.

At the Altenheim, Chicago, Illinois, and known to William S. MacHarg, of Chicago, Illinois, and Henry W. Hill, of Chicago, Illinois.

At Lake Forest, Illinois, residence of Slason Thompson, and known to W. S. MacHarg, of Chicago, Illinois. 4533

VILLAGE OF SARATOGA SPRINGS, and the SEWER, WATER AND STREET COMMISSION OF SARATOGA SPRINGS,

By their Solicitor,

JNO. J. HEALEY, JR.

CHARLES L. STURTEVANT,

Of Counsel. 4534

STIPULATION.

It is hereby stipulated that the foregoing amendment to the answer may be filed as of this date, the proofs being closed and the case ready for hearing.

GIFFORD & BULL,

LIVINGSTON GIFFORD,

Of Counsel for Complainants.

Dated, October 23rd, 1906.

4535 UNITED STATES CIRCUIT COURT, NORTHERN DISTRICT OF NEW YORK.

CAMERON SEPTIC TANK COMPANY, vs. VILLAGE OF SAGATOGA SPRINGS AND THE SEWER, WATER AND STREET COMMISSION OF SARATOGA SPRINGS, N. Y.	*In Equity,* *No. 7025.*

4536

STIPULATIONS.

For the purpose of saving time and expense to the respective parties, it is hereby stipulated and agreed as follows:

4537 1. That the testimony to be produced in this cause by either party may be taken orally under the provisions of Equity Rule 67 as amended, before any notary public, United States Commissioner, or other officer qualified in the premises.

2. That a certified copy of the patent in suit, namely, patent No. 634,423, granted Oct. 3, 1899 to
4538 Cameron, Commin & Martin, shall be received and accepted for all purposes of this suit with the full force and effect of the original patent.

3. That certified copies of assignments or licenses offered by either party hereto in support of title shall be accepted with the same force and effect as though they were original instruments.

4539 4. That uncertified copies of United States Letters Patent referred to by the defendants in their answer may, for the purposes of this suit, be used with equal force and effect as would certified copies thereof.

5. That any exhibits, specimens or models introduced on behalf of either party hereto may be re-

tained by the party offering them up to the time 4540
when they are needed in court, subject to the right
of inspection and production by the opposite party
at all convenient times and places, and that said
exhibits, specimens and models may be used by
either party where depositions are to be or may
be taken, subject to the above mentioned conditions
and restrictions. 4541

6. It is admitted by counsel for the defendant that the Cameron Septic Tank Company, of Chicago, the complainant herein, is a corporation created by and existing under the laws of the State of Illinois, and a citizen of said State and was so at the filing of the bill of complaint.

G. H. HOWARD, 4542
Solicitor for Complainant.

EDGAR T. BRACKETT,
J. P. BRENNAN,
Solicitor and of Counsel for Defendant.